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UNITED STATES ARMY,

TO THE

SECRETARY OF WAR

FOR

THE YEAR 1894.

IN SIX PARTS.

PART IV.

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TO THE

REPORT OF THE CHIEF OF ENGINEERS,

UNITED STATES ARMY.

(CONTINUED.)

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IMPROVEMENT OF RIVERS AND HARBORS ON LAKE SUPERIOR.

REPORT OF MAJ. CLINTON B. SEARS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Grand Marais, Minn.
2. Harbor at Agate Bay, Minnesota.
3. Harbor at Duluth, Minn.
4. Harbor at Superior Bay and St. Louis Bay, Wisconsin.
5. Harbor at Ashland, Wis.
6. Harbor at Ontonagon, Mich.
7. Eagle Harbor, Michigan.
8. Waterway from Keweenaw Bay to Lake Superior, Michigan.
9. Harbor at Marquette, Mich.
10. Harbor of refuge at Grand Marais, Mich.

HARBOR LINES.

11. Superior Bay, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Duluth, Minn., July 10, 1894.

GENERAL: I have the honor to transmit herewith my annual reports * * * for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

I I 1.

IMPROVEMENT OF HARBOR AT GRAND MARAIS, MINNESOTA.

The harbor of Grand Marais, Minn., is the only harbor of refuge on the north shore of Lake Superior between Agate Bay (Two Harbors) and the international boundary line.

Rich mineral deposits are alleged to exist in the back country. Should these be opened up and connected with the lake by railroad, the harbor may become of some importance for the shipment of ore.

The approved project of 1879 is to build two breakwater piers, each 350 feet long, from the east and west points of the bay, or one pier 700 feet long from the east point, and dredge an anchorage area of about 26 acres to a depth of at least 16 feet, all at an estimated cost of $139,669.40.

The object of this work is to provide a harbor for purposes of refuge and commerce, which it has fully accomplished as far as completed.

The improvement of the harbor commenced in 1880. At the present time the length of completed breakwater is 350 feet, or one-half of the whole, and the 16-foot anchorage is 23.5 acres in extent. This leaves 2.5 acres to be dredged to complete this part of the project.

This anchorage gives room for the safe swinging at anchor of a few vessels only, and should be increased to the full capacity of the harbor, which has an area of about 61 acres. To protect this area properly would require a further extension of the pier of some 500 feet instead of 350 feet as provided for in the present project.

The last river and harbor act, that of July 13, 1892, appropriated $10,000 to continue the improvement of this harbor. Most of this was expended between July 1 and November 1, 1893, in dredging the anchorage area to the above total of 23.5 acres, under contract with Messrs. Williams, Daugherty & Upham. About 39,131 cubic yards were taken out at a cost of 23 cents per yard. The material consisted of sand, gravel, and small bowlders. An inspection made in June, 1894, shows the anchorage area to be intact and the pier in good condition, barring some slight abrasions by the ice.

Of the original estimated cost of the present approved project, $127,350 has been appropriated, requiring $12,319.40 to complete the estimate. This amount, however, will not complete the project. With the small available balance on hand at the close of the working season, it will dredge the 2½ acres necessary for completion of dredging project, and will build about 50 feet of pier extension, instead of 350 feet as embodied in project.

This work is in the collection district of Duluth, Minn.; Duluth, Minn., is the nearest port of entry. The nearest light-house is situated on the breakwater at Grand Marais.

ESTIMATES.

Original (estimated) amount required to complete the improvement	$139,669.40
Amount necessary to complete the present project as originally estimated and which can be profitably expended in next fiscal year	12,319.40

Abstract of appropriations for improving harbor at Grand Marais, Minn.

By act of Congress—	
Approved March 1, 1879	$10,000
Approved June 14, 1880	10,000
Approved March 3, 1881	20,000
Passed August 2, 1882	20,000
Approved July 5, 1884	10,000
Approved August 5, 1886	10,000

By act of Congress—	
Passed August 11, 1888	$15,000
Approved September 19, 1890	22,350
Approved July 13, 1892	10,000
Total	127,350

EXPENDITURES.

Amount expended under approved project to June 30, 1894	$126,159.93
Balance available July 1, 1894	1,190.07

Money statement.

July 1, 1893, balance unexpended	$10,879.82
June 30, 1894, amount expended during fiscal year	9,689.75
July 1, 1894, balance unexpended	1,190.07
Amount (estimated) required for completion of existing project	12,319.40
Amount that can be profitably expended in fiscal year ending June 30, 1896	12,319.40
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Minn., for 1893.

Designation.	Arrivals.	Clearances.	Total.
Coastwise	80	80	160
Foreign	53	53	106
Total	133	133	266

No new lines of transportation were established.

Freight received and shipped, 1893.

	Tons.
Receipts:	
Grain	21
Flour	18
Mill stuffs	76
Coal	35
Lumber	201
General merchandise	511
Miscellaneous	5
Total	867
Shipments:	
Fish	30
Sand and gravel	7,595
Total	7,625

Freight received and shipped for twelve years.

Year.	Tons.	Value.	Year.	Tons.	Value.
1882	224	$25,691	1888	460	$44,871
1883	239	27,595	1889	252	29,349
1884	270	30,198	1890	275	32,035
1885	390	41,484	1891	319	32,687
1886	475	43,519	1892	756	65,374
1887	312	29,059	1893	907	78,460

Arrivals and clearances of vessels for twelve years.

Year.	Arrivals.	Clearances.	Year.	Arrivals.	Clearances.
1882	134	134	1888	190	190
1883	131	131	1889	168	168
1884	152	158	1890	268	268
1885	188	190	1891	160	159
1886	210	210	1892	146	145
1887	164	164	1893	133	133

I I 2.

IMPROVEMENT OF HARBOR AT AGATE BAY, MINNESOTA.

Agate Bay, on which is situated the town of Two Harbors, Minn., is a semicircular harbor of 2,000 feet radius. There is a good navigable depth throughout the greater part of the harbor, but it is exposed to storms from the southwest and from reverse swells of hard storms from the northeast.

The natural shelter it afforded justified the erection of three extensive ore docks by the Duluth and Iron Range Railroad, also a good commercial dock and a dock for landing coal.

The rapid increase in the commerce of the harbor caused Congress to undertake its improvement by an appropriation of $22,500 in August, 1886.

The approved project of 1887 was to construct two breakwater piers on a line toward each other from the eastern and western points of the bay, to be 1,000 feet and 900 feet long, respectively, leaving an opening of 1,340 feet between their extremities and inclosing an area of 109 acres.

The original estimate of cost was $213,000, which was increased to $244,208 in annual report of 1887 on account of higher prices.

The object is to protect shipping at the wharves which otherwise would be greatly exposed. Work was commenced in 1887 on the east pier, which is now 750 feet in length, leaving 250 feet to be built to complete it; the work is, therefore, a little more than one-third done, but the remaining two-thirds will cost considerably more than twice what has already been expended, for the reason that it is in much deeper water.

There is not yet perfect security from southwest storms for vessels lying at the merchandise dock, but it is no longer necessary to leave the harbor and seek security elsewhere. The favorable results already obtained with the portion of the breakwater now built are much greater than anticipated, and emphasize the advisability of speedily completing the remainder of the projected piers.

The Duluth and Iron Range Railroad has now in successful operation four large ore docks, and expects to build another as soon as the financial situation now existing throughout the country becomes better.

At the close of the last fiscal year a contract with Messrs. Powell & Mitchell was in force to build 200 feet of the west pier. This contract was duly completed within the time called for. An inspection made in June, 1894, showed these two piers to be in good condition.

The Iron Range is the only railroad using this harbor as a shipping point, and the business of the place has heretofore been entirely subsidiary to the iron-ore interests of the Vermilion range, but the immense quantities of excellent iron ore recently developed in the Missabe range bid fair to be quite as important as the former, and are likely to seek an outlet through Agate Bay.

Of iron ore alone there were shipped from this port during the season of 1893, 902,268 net tons.

Agate Bay, known locally as Two Harbors, is in the collection district of Duluth, Minn., which is also the nearest port of entry. The nearest light-house is situated on the east point, Agate Bay, Minnesota.

Abstract of appropriations for improving harbor at Agate Bay, Minnesota.

By act of Congress—	
Approved August 5, 1886	$22,500
Passed August 11, 1888	15,000
Approved September 19, 1890	25,000
Approved July 13, 1892	30,000
Total	92,500

EXPENDITURES.

Amount expended under approved project to June 30, 1894	$89,222.24
Balance available July 1, 1894	3,277.76

ESTIMATES.

Amount necessary to complete the present approved project as based on the last estimate of 1887 .... $151,708

At the present prices, the water being much deeper, this amount will build only 700 feet of the 950 feet of pier yet to be built.

Amount required annually for preserving and maintaining the improvement after completion $2,000

Money statement.

July 1, 1893, balance unexpended	$30,388.42
June 30, 1894, amount expended during fiscal year	27,110.66
July 1, 1894, balance unexpended	3,277.76
Amount (estimated) required for completion of existing project	151,708.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	151,708.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Vessels arriving and departing at Agate Bay, Minnesota.

Year.	Vessels.	Estimated tonnage.	Increase.
1885	174	295,800	....
1886	263	460,000	164,200
1887	465	697,500	237,500
1888	749	1,436,000	738,500
1889	1,255	2,400,000	964,000
1890:			
Steam, 968	1,050	2,625,000	225,000
Sail, 82			
1891:			
Steam, 1,188	1,250	2,915,000	290,000
Sail and whaleback, 62			
1892:			
Steam, 1,104	1,330	3,101,600	186,600
Sail, 186			
Whaleback, 40			
1893:			
Steam, 1,016	1,178	2,386,200	−715,400
Sail, 146			
Whaleback, 16			

Receipts and shipments.

Year.	Ore shipped.	Other freight received and shipped.	Total.
	Tons.	*Tons.*	*Tons.*
1885	225,484	10,895	236,379
1886	304,396	21,954	326,350
1887	394,252	6,620	400,872
1888	509,964	30,352	540,316
1889	924,054	31,731	955,785
1890	984,215	37,268	1,021,483
1891	1,000,052	41,181	1,041,233
1892	1,304,885	54,477	1,359,362
1893	902,268	57,616	959,884

Estimated value of freight received and shipped (exclusive of ore).

Year.	Amount.	Year.	Amount.
1887	$96,000	1891	$225,000
1888	212,000	1892	320,000
1889	222,000	1893	360,000
1890	246,000		

There were no new lines of transportation established last year.

I I 3.

IMPROVEMENT OF HARBOR AT DULUTH, MINNESOTA.

THE CANAL OR ENTRY.

The question of ownership of the land occupied by the canal is still unsettled and is somewhat complicated, owing to the deed of the city of Duluth to the platted lots having been accepted in part only by the act of Congress of August 11, 1888, to the claims of the late Mr. Wilhelm Boeing to property not included in the deed but covered by the canal, and to the fact that the city of Duluth has never vacated to the United States the underlying portions of streets.

An investigation of this question of ownership was ordered in the act of July 13, 1892, and the report concerning it was published in House Ex. Doc. No. 122, Fifty-second Congress, second session.

The piers which form the banks of the canal are greatly in need of renewal, but this should not be undertaken, nor even extensive repairs put on, until the title of the United States to all the land needed has been clearly established.

Twenty-five thousand dollars should be available for repairs.

While the piers were built for a depth in the canal of only 12 feet, they show no signs of giving way with an existing depth of from 18 to over 30 feet, which means that they will not have to be rebuilt at present for a new 22-foot channel.

During the past fiscal year $820.12 were expended in repairing the outer end of the north pier to protect it against the attacks of ice and rafts.

THE HARBOR BASIN.

No work has been done upon the harbor basin during the year, and no complaints of shoaling have been heard. This basin should be enlarged where it joins the new channel east of Rice Point, as boats are constantly backing out from one wharf to move to another. A large majority of the vessels bound to West Superior come in through the canal and pass through this basin and the new channel over to the West Superior wharves. At least $75,000 could be profitably expended in this work during the next year.

RICE POINT CHANNEL.

The dredging for the new channel east of Rice Point was commenced in 1889. The length of this channel is 1.6 miles. The present project calls for a width in this channel of 200 feet. It should be at least 400 feet wide, safely and conveniently to accommodate the traffic now passing through it.

It is used by numerous tugs, light, or with large rafts of logs in tow, and the ferryboats make hourly trips in both directions. No small portion of the vessels passing through this channel go to West Superior, so that money spent on this as well as on the harbor basin is for the benefit of that place as well as Duluth. It is at present by far the most important part of the harbor improvement at the head of the lakes, and $100,000 could be profitably expended upon it during the next fiscal year.

Under the agreement in force at the close of the last fiscal year, with Messrs. Williams, Daugherty & Upham, some 30,548 cubic yards have been dredged since July 1, 1893, giving a depth of 16 feet and a width of 200 feet, with 250 to 300 feet width at the bend.

NORTH SHORE CHANNEL, ST. LOUIS BAY.

This channel runs from the end of Rice Point around parallel to the dock line, along the north side of the bay, till it meets the channel along the south shore. They join opposite West Duluth. At the close of navigation in 1893 this channel had a width of from 160 to 250 feet, with a ruling depth of over 16 feet, secured under contract with Messrs. Williams, Daugherty & Upham. To complete the widening of this channel to 200 feet will require $35,000, which can be advantageously expended during the next fiscal year.

This channel is having increased use every year, and is of great importance to the commercial interests west of Rice Point. The Missabe and Northern Railroad Company has built, probably, the largest ore dock in the United States, and other commercial industries will locate themselves there as soon as the country is relieved from the present financial depression.

PARK POINT CHANNEL.

Nothing has been done to this proposed channel. The approved project calls for a channel 2,640 feet long, parallel to Minnesota Point on the northerly side of Superior Bay, and near the established harbor line. To give this a navigable depth of 16 feet and a width of 200 feet will require $33,000, but as this portion of the harbor is not at present available for dockage purposes, the dredging of this channel can be advantageously deferred, a deepening of all the existing channels to a navigable depth of over 20 feet being of much greater importance, in view of of the early completion of the 20-foot project between Buffalo and Duluth.

ST. LOUIS RIVER ABOVE GRASSY POINT.

The St. Louis River above Grassy Point has a depth of over 10 feet for several miles and 8 feet to Fond du Lac Station. Four or 5 feet can be carried up to the foot of the rapids, from which point up, the river has a fall of about 400 feet in less than 7 miles. The utilization of this immense water power has already been commenced, the first dam, located at Thomson, being completed and giving a head of 16 feet. A deep navigable channel to Fond du Lac is essential to the success of any enterprise in this locality.

From Grassy Point for several miles up the river there are pools of from 500 to several thousand feet in length, having widths of over 200 feet and depths of from 17 to 27 feet. Between the pools are shoaler reaches of only 10 feet depth.

Under the above contract, some 107,143 cubic yards were dredged through the shoal places between pools. Much of the material removed was sawdust, the tailings of the lumber mills on the upper river. The dredging gave the bars a width of 95 to 100 feet and a depth of 17 feet, thus securing good 16-foot navigation up to Ironton, 4½ miles above Grassy Point.

The estimated cost of a channel 100 feet wide and 16 feet deep from Grassy Point to the deep pool near Fond du Lac is $112,822.88 (see report of survey of St. Louis River*); deducting the $22,500 already expended will leave $90,332.28 required to complete the project.

A complete map of Duluth Harbor was published in the last Annual Report, Appendix J J.

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*Appendix H H 11, Report of Chief of Engineers, 1892.

GENERAL REMARKS.

As Congress has sanctioned by legislation the project of a 20-foot waterway between Buffalo and Duluth, and as the channels in Superior and St. Louis bays are the last connecting links in this chain of improved navigation, it may be proper to invite attention to the wisdom of providing for an early increase in the depths of these channels to an available depth of 20 feet, which means 22 feet in actual depth, so as to have them ready to meet the completion of the 20-foot channel at the Sault Ste. Marie and elsewhere.

Nearly 60 per cent of the commerce passing the Sault Ste. Marie comes to Duluth and Superior, and unless vessels drawing 20 feet can readily and safely enter the Superior and Duluth entrances and get up to their docks, the rest of the improvement, costing very many times that of the betterment needed at this end, will be of but limited use.

The estimates for 20-foot channels in Duluth and Superior harbors were given in Report of Chief of Engineers, 1892. Appendixes H H 3 and H H 4, pp. 2128–2137.

I renew my recommendation of last year that the United States purchase an efficient dredging and pile-driving plant for the general use of the district, the cost, some $65,000, to be divided among the various works in proportion to their relative importance.

This work is in the collection district of Duluth, Minn., which is also the port of entry. The nearest light-house is situated on the outer end of the south pier of the Duluth Canal, and a range light is located on the inner end of the same pier.

Abstract of appropriations for improving harbor at Duluth, Minn.

By act of Congress approved—	
March 3, 1871	$60,000.00
June 10, 1872	50,000.00
Allotted from act passed March 3, 1873	36,049.20
By act of Congress approved—	
June 23, 1874	10,000.00
March 3, 1875	35,000.00
August 14, 1876	15,000.00
June 18, 1878	30,000.00
March 3, 1879	25,000.00
June 14, 1880	25,000.00
March 3, 1881	40,000.00
By act of Congress passed August 2, 1882	45,000.00
By act of Congress approved—	
July 5, 1884	45,000.00
August 5, 1886	56,250.00
By act of Congress passed August 11, 1888	80,000.00
By act of Congress approved—	
September 19, 1890	100,000.00
July 13, 1892	125,000.00
Total	777,299.20

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of soundings, superintendence, buoying, and contingencies:

Total amount expended to June 30, 1894:	
Breakwater	$110,000.00
Canal piers, etc	88,801.49
Dredging	569,180.04
Total	767,981.53

Expended prior to present project:	
Breakwater	$110,000.00
Canal piers, etc	45,698.33
Dredging	114,953.48
Total	270,651.81
Expended under the present project (adopted in 1881):	
Canal piers, etc	43,103.16
Dredging	454,226.56
Total	497,329.72

Money statement.

July 1, 1893, balance unexpended	$90,844.41
June 30, 1894, amount expended during fiscal year	81,526.74
July 1, 1894, balance unexpended	9,317.67
Amount (estimated) required for completion of existing project	122,026.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	237,322.88

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

The above balance is held as a reserve fund against accidents to piers or channels.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Duluth, Minn., for 1892 and 1893.

Designation.	1893.				1892.			
	Arrivals.	Clearances.	Total.	Tonnage.	Arrivals.	Clearances.	Total.	Tonnage.
Coastwise	1,462	1,496	2,958	3,588,008	1,508	1,535	3,043	3,519,468
Foreign	180	167	347	246,387	227	212	439	291,184
Total	1,642	1,663	3,305	3,834,395	1,735	1,747	3,482	3,810,652

Comparative statement of arrivals and clearances, 1892 and 1893.

Year.	Vessels.	Tonnage.	Average tonnage.
1892	3,482	3,810,652	1,095
1893	3,305	3,834,395	1,160
Increase	*177	23,743	65

* Decrease.

Principal domestic commodities received and shipped by lake, 1893.

Receipts.	Tons.	Shipments.	Tons.
Coal	1,124,771	Wheat	591,788
Cement	4,545	Flour	301,988
Lime and building stone	20,123	Corn and oats, etc	5,000
Salt	12,391	Flax seed	4,000
Sugar	6,834	Mill stuffs	11,483
Manufactured iron	5,780	Iron ore	493,127
Staves	2,541	Copper	15,704
Sand and gravel	78,000	Lumber	107,020
General merchandise	222,648	Miscellaneous merchandise	54,199
Total	1,477,633	Total	1,584,309

Receipts of coal and shipments of flour eastward for eleven years.

Year.	Coal.	Flour.	Year.	Coal.	Flour.
	Tons.	*Tons.*		*Tons.*	*Tons.*
1883	420,000	91,896	1889	1,045,000	198,053
1884	372,000	79,801	1890 *	735,995	149,112
1885	695,000	113,190	1891	778,982	170,774
1886	736,000	133,036	1892	1,168,068	288,483
1887	1,041,000	129,627	1893	1,124,771	301,988
1888	1,435,000	171,223			

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* Coal receipts prior to 1890 are given for the head of the lake (Duluth and Superior); since then for Duluth only.

The storage capacity of Duluth elevator system is 25,950,000 bushels, and that of Duluth elevators proper 12,650,000 bushels. The following table gives the receipts and shipments of wheat for twenty-three years:

Year.	Receipts.	Shipments.	Total.	Year.	Receipts.	Shipments.	Total.
Ending Dec. 31—	*Tons.*	*Tons.*	*Tons.*	Ending Aug. 31—	*Tons.*	*Tons.*	*Tons.*
1893	987,312	1,011,025	1,998,337	1882	97,987	99,264	197,251
1892	1,399,817	982,222	2,382,039	1881	99,965	85,966	185,931
1891	1,144,082	1,058,449	2,202,531	1880	40,430	43,610	84,040
1890	460,244	427,725	887,969	1879	45,722	44,617	90,339
1889	513,827	409,410	923,237	1878	54,092	54,000	108,092
1888	239,802	404,485	644,287	1877	13,817	15,117	28,934
1887	514,089	585,558	1,099,647	1876	43,536	41,292	84,828
1886	675,977	530,048	1,206,025	1875	34,137	32,436	66,573
1885	446,590	421,973	868,563	1874	67,224	72,725	139,949
1884	411,688	346,537	758,235	1873	59,444	47,495	106,939
Ending Aug. 31—				1872	27,948	28,531	56,479
1883	141,234	137,607	278,841	1871	16,703	16,345	33,048

The above figures show the movement of wheat at the head of the lake (Duluth and Superior combined).

Average vessel tonnage for nine years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1885	761	1888	887	1891	1,129
1886	778	1889	970	1892	1,095
1887	812	1890	1,081	1893	1,160

Comparative statement of arrivals and clearances of vessels at Duluth for seventeen years.

Year.	Arrivals.	Clearances.	Total.	Year.	Arrivals.	Clearances.	Total.
1877	329	228	557	1886	1,026	995	2,021
1878	406	343	749	1887	1,237	1,238	2,475
1879	502	497	999	1888	1,100	1,100	2,200
1880	524	524	1,048	1889	1,263	1,265	2,528
1881	666	660	1,326	1890	1,266	1,268	2,534
1882	833	832	1,665	1891	1,444	1,451	2,895
1883	796	779	1,475	1892	1,735	1,747	3,482
1884	888	903	1,791	1893	1,642	1,663	3,305
1885	808	989	1,797				

Comparative statement of imports and exports.

Year.	Imports.	Duties.	Tonnage duty.	Total duties.	Value of domestic exports.
1888	$86,901	$2,909.00	$23.40	$2,932.40	$1,207,858
1889	21,852	2,931.00	49.80	2,980.80	1,405,447
1890	48,027	5,255.86	13.20	5,269.06	1,521,751
1891	155,446	4,764.97	86.40	4,851.37	2,079,173
1892	117,759	16,706.28	127.84	16,834.12	1,837,936
1893	130,797	14,496.34	154.89	14,651.23	1,419,699

Opening and closing of navigation.

Year.	Opening.	Closing.	Year.	Opening.	Closing.
1885	Apr. 27	Nov. 29	1890	Apr. 16	Dec. 8
1886	May 7	Dec. 14	1891	Apr. 30	Dec. 6
1887	May 4	Dec. 28	1892	Apr. 16	Dec. 30
1888	May 11	Dec. 31	1893	May 9	Dec. 1
1889	Apr. 11	Dec. 4	1894	Apr. 19	....

II 4.

IMPROVEMENT OF HARBOR AT SUPERIOR BAY AND ST. LOUIS BAY, WISCONSIN.

The natural channel connecting Superior Bay with Lake Superior is at the southern extremity of Superior Bay. It was originally obstructed by shifting bars with scarcely 9 feet of water over them, to remedy which the citizens of Superior, previous to 1866, had made some attempts at pier work, which was subsequently taken in hand by the United States and the improvements continued until the piers have reached an aggregate length of 5,650 feet.

When the improvement was commenced 12 feet depth in the channel was more than sufficient to meet the requirements of the largest vessels. This depth has been increased, and maintained for some time at 17 feet, and at no distant day will have to be still further increased to 22 feet. The crib piers which define this channel are in most part badly conditioned for the present depth of 17 feet, they having been intended originally for not over 12 feet. A further increase in the depth of the channel may possibly make it necessary to replace them with better proportioned structures.

In the meantime the superstructures will have to be extensively repaired. It is in the interest of economy, as matters stand at present, to postpone all general repairs to the latest moment pending the consideration of the subject of reconstruction, but it is hoped that the greater portion of the present substructure cribs can be retained.

Five thousand five hundred and sixty-two dollars and twenty cents were expended last fall in repairing and strengthening the outer ends of the piers to protect them from ice and rafts.

Further repairs will have to be made this season.

The shore on the Wisconsin side is advancing rapidly, and soon the sand which drifts around the end of the Wisconsin pier will necessitate the extension of this pier.

The Land Office having decided that the title to the land on Wisconsin Point, where the southerly pier is situated, is not vested with the United States, it will be necessary to take steps to acquire title to a strip sufficiently wide to include the pier and ground enough for a future widening of the channel.

Under the contract with C. S. Barker, in force at the close of the last fiscal year, 68,966 cubic yards were dredged out from between the piers, leaving a channel with minimum width of 180 feet and depth of 17 feet.

CHANNEL IN SUPERIOR BAY.

The channel in Superior Bay has neither the directness nor width to permit vessels to reach Connors Point safely without the assistance of a tug or local pilot, though its condition has been vastly improved in the past few years. Its present condition is good, but vessels bound for West Superior will not use it so long as the shorter and much easier route through Duluth Canal is in good condition. It is used considerably, however, by rafts, and should not be allowed to deteriorate.

In order that vessels may navigate this channel at all times safely, it is essential that it be widened and straightened considerably.

In this connection attention is invited to the interest in common of West Superior and Duluth in the anchorage basin inside the Duluth Canal and the channel along the east side of Rices Point.

QUEBEC CHANNEL.

This was widened and deepened under the above contract and left with a minimum width of 200 feet and depth of 16 feet.

THE NEMADJI RIVER.

The bar at its mouth is a serious obstruction and was dredged in 1891. It will probably require redredging each year after the spring floods to maintain a serviceable channel; this will require about $5,000 annually.

SUPERIOR DOCK LINE CHANNEL, SUPERIOR BAY.

This channel as proposed will extend from the Northern Pacific coal dock, opposite the Quebec Channel, northerly to the main natural channel at Connors Point, and parallel to and 150 feet from the dock line. The city of Superior started this channel and completed some 4,300 feet, with a depth of 19 feet and a width of from 100 to 130 feet. Under the above contract the United States widened this channel to a minimum of 16 feet in depth over a length of some 3,300 feet, leaving as the joint result of city and United States dredging a channel some 4,400 feet in length, with a width of 300 feet along 3,200 feet, of 250 feet along 200 feet, and 130 feet along the balance.

CHANNEL ALONG WISCONSIN DOCK LINE, ST. LOUIS BAY.

The projected channel between Connors Point and Grassy Point along the West Superior dock line is 11,850 feet in length, and has a width of from 60 to 200 feet, with a minimum depth of 16 feet.

The last 3,300 feet of this channel was dredged during the past year under the above contract. Vessels drawing 16 feet can now reach Grassy Point by two channels, one on the north and the other on the south side of St. Louis Bay.

GENERAL REMARKS.

The approved project of 1881 provides for the maintenance of piers at the natural entry and dredging between them a channel 300 feet wide and 16 feet deep; a channel 150 feet wide from the entry past Nemadji River to Quebec Dock parallel to shore; a channel 100 feet wide from Quebec Dock along southerly side of Superior Bay to St. Louis River opposite Connors Point, and the preservation of the old Quebec Channel; and in 1884 Congress authorized the improvement of the St. Louis River Channel in St. Louis Bay, and in 1892 it authorized the dredging of a channel along the dock line on south side of Superior Bay between the Quebec Channel and the main channel opposite the base of Connors Point.

As far as depth is concerned the project is completed. None of the existing channels are sufficiently wide, however, to permit vessels to enter or leave the dock slips safely. There is great danger of their colliding with the farther bank and injuring their steering or propelling apparatus in doing this. Furthermore, this movement is a slow one and practically blocks the channel until the maneuver is completed. The channels should be widened to 400 feet in the vicinity of the docks, and 300 feet elsewhere.

A complete map of Superior Harbor was printed in the last Annual Report, Appendix J J.

Superior, West Superior, and Connors Point are in the collection district of Superior, Wis., Marquette, Mich., being the port of entry. The nearest light-house is situated on the outer end of south pier of the Superior entry.

Recommendations for next year.

For repair fund for entry piers	$30,000
For the channels in Superior Bay	50,000
For dredging at the mouth of the Nemadji River	5,000
For channel in St. Louis Bay	75,000
Total	160,000

Abstract of appropriations for improving harbor at Superior Bay and St. Louis Bay, Wisconsin.

By act of Congress approved—	
March 3, 1867	$63,000.00
April 10, 1869	45,000.00
July 7, 1870	40,000.00
March 3, 1871	60,000.00
June 10, 1872	50,000.00
Allotted from act approved March 3, 1873	63,950.80
Allotted from appropriation for "repairs of harbors on northern lakes"	5,433.00
By act of Congress approved—	
August 14, 1876	3,000.00
June 18, 1878	3,000.00
March 3, 1879	5,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00
August 2, 1882	40,000.00
July 5, 1884	45,000.00
August 5, 1886	22,500.00
By act of Congress passed August 11, 1888	50,000.00
By act of Congress approved September 19, 1890	65,000.00
By act of Congress approved July 13, 1892	70,000.00
Total	645,883.80

EXPENDITURES.

Amount expended under original project adopted in 1867	$258,000.00
Amount expended under project recommended by Board of Engineers in 1873	77,513.26
Amount expended under present project to June 30, 1894	295,339.92
Total	630,853.18

The following statement shows the manner in which the appropriations have been expended. The amount expended under the different classes of work includes the cost of examinations, soundings, superintendence, buoying, and contingencies.

Repairs and beach protection	$13,233.00
Construction and repair to piers	324,005.73
Dredging	293,614.45
Total	630,853.18

Money statement.

July 1, 1893, balance unexpended	$88, 066. 68
June 30, 1894, amount expended during fiscal year	73, 036. 06
July 1, 1894, balance unexpended	15, 030. 62
Amount (estimated) required for completion of existing project	156, 736. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	156, 736. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

The above balance is held as a reserve fund for repairs, etc

Abstract of proposals for repairs to piers at the Superior entrance to Superior Bay, Wisconsin, received at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers. Opened July 31, 1893.

No.	Name and address of bidder.	For removing old work and furnishing new material and placing in position and securing the 12 by 12 inch upright timbers around and inside ends of pier, and the steel-plate sheeting, in total.	For removing old work and furnishing new material and placing in position and securing the balance of the work, including the necessary shifting of stone ballast, per M feet, B. M., of new timber supplied in place, about 160,000 feet.	For stone ballast in place, either inside work as a filling or outside as riprap, per cord, 80 cords, more or less.	Total.
1	W. E. Moran & Co., West Superior, Wis.	$1, 333. 76	$22. 00	*$1, 195. 30	$6, 049. 06
2	John J. Lynch and Hugh Campbell, Duluth, Minn	1, 297. 23	24. 50	7. 00	5, 777. 23
3	Edward McCue, Duluth, Minn	1, 237. 80	17. 70	6. 50	4, 589. 80
4	George Taylor, Duluth, Minn	1, 487. 00	25. 40	7. 00	6, 111. 00
5	Ornan W. Fish and Simon Dumond, Duluth, Minn	1, 835. 00	19. 50	10. 00	5, 755. 00
6	Shipley & Co., Duluth, Minn	1, 448. 00	23. 00	11. 50	6, 048. 00
7	Hugh Steele, Duluth, Minn	940. 00	21. 00	5. 40	4, 732. 00
8	W. A. Whitney, West Superior, Wis	1, 225. 00	18. 25	7. 50	4, 745. 00
9	Louis C. Meining, Duluth, Minn	1, 663. 69	18. 20	12. 00	5, 535 69
10	Campbell & McDonald, Duluth, Minn	2, 120. 00	26. 00	8. 00	6, 920. 00
11	Hood & Kinghorn, Duluth, Minn	1, 184. 69	20. 30	9. 10	5, 160. 69
12	Fred A. Dole, Superior, Wis	1, 152. 00	20. 00	7. 50	4, 952. 00

* Total.

Contract awarded to Edward McCue, with the approval of the Chief of Engineers, August 14, 1893.

Contract dated August 10, 1893. Work to be completed by November 1, 1893.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Superior, Wis., for two years.

Year.	Arrivals and clearances.	Tonnage.
1892	1, 940	2, 496, 507
1893	1, 909	2, 571, 917
Increase		75, 410
Decrease	31	

Average vessel tonnage.

1893	1,347
1892	1,287
Increase	60

Of the number of vessels reported above for 1893, 1,454 were steam and 455 sailing vessels.

There were built by American Steel Barge Company, at Superior during the year 1893:

	Tonnage.
1 steel passenger steamer	1,511
5 steel barges	7,866

The storage capacity of the Superior elevators is 11,000,000 bushels.

Shipments and receipts by lake of leading articles during season of 1892.

Article.	Tons.	Article.	Tons.
*SHIPMENTS.		RECEIPTS.	
Wheat	340,450	Coal	1 196,619
Other grain	3,150	Cement	3,242
Flour	258,995	Sugar	3,168
Wool	150	Oil	750
Bran	6,296	Salt	5,045
Copper ore	21,272	Miscellaneous	5,000
Lumber	33,415		
Iron ore	34,920	Total	1,213,824
Canned goods	878		
		Total receipts and shipments	1,913,350
Total	699,526		

Comparative statement of receipts and shipments for ten years.

Year.	Tons.	Year.	Tons.	Year.	Tons
1884	17,462	1888	327,327	1892	1,733,444
1885	33,626	1889	1,006,542	1893	1,913,350
1886	117,027	1890	1,495,385		
1887	170,020	1891	1,616,648		

Comparative statement of arrivals and clearances of vessels for ten years.

Year.	Vessels.	Tonnage.	Year.	Vessels.	Tonnage.
1884	194	119,288	1889	900	1,122,048
1885	200	113,519	1890	1,256	1,541,777
1886	316	283,787	1891	1,610	2,984,463
1887	462	404,780	1892	1,940	2,498,507
1888	812	915,816	1893	1,909	2,571,917

I I 5.

IMPROVEMENT OF HARBOR AT ASHLAND, WISCONSIN.

The southern end of Chequamegon Bay forms the harbor of Ashland, and as the length of the bay is considerable it was necessary to protect the wharves from the waves to enable vessels to use them at all times. The approved project is for the construction of a pile, slab, and rock breakwater 8,000 feet long, dredging a channel of the necessary depth along the dock line, and closing the breach in Chequamegon Point with a brush and stone dike.

The breakwater consists of three rows of piling filled in with slabs, which are anchored with large rock.

This construction has only its cheapness to commend it. In the long run, however, it will prove very expensive, as, ultimately, it will have to be reinforced with a solid bank of riprap.

Under the contract in force at the close of the last fiscal year, 600 feet were added to the outer end and 1,080 feet to the inner end of the breakwater, making the total length 7,363 feet. The work was, for this kind of structure, very substantially done, much more so than any of the old work.

The breakwater is still of insufficient length to give protection to all the wharves of the city, but its influence in diminishing the turbulence of the waters of the harbor is distinctly apparent.

An unusually severe storm, May 18, 1894, damaged the old work first put in, that of 1889, to the extent of some $8,000. But $3,200 were available for repairs. This is being expended for repairing and strengthening the weakest portions. No attempt is being made to close the existing gaps. At least $5,000 should be immediately available for complete repairs. A long delay will necessitate the doubling of this estimate.

The same storm made a breach through Chequamegon Point, which, when inspected in June, had a width roughly estimated at 600 feet, with a measured depth of 2½ to 4½ feet along the shoalest line. The breach took place at one of the strongest parts of the point, to the north of the protection work put down in 1891, and it widened till it reached the head of the protection work, where it stopped. It is liable to widen still more in the other direction, however. It will cost $10,000 to close it as it now exists. No great permanent deepening is apprehended, as the bottom is well riprapped with gravel and cobble stones, which have subsided as the sand washed out, and as the same natural forces that built up the point are still in operation. The protection work of brush and stone put in in 1891 had, by 1893, subsided over a length of some 400 feet, so as to permit a small flow of water across the point. This was raised and strengthened in 1893 under a contract with Hugh Steele. The inspection in June showed this new work, as well as the old, to be in good condition and greatly strengthened by an accumulation of sand in front.

To complete the breakwater as originally projected will cost $20,000. Much stronger work should be put in, however, and it will be economy to spend on the remaining 637 feet $30,000 instead of $20,000.

A harbor line has been established by the city, but there is not a uniformity of depth along it. To give a channel 200 feet wide and 17 feet deep along this dock line, about 425,000 cubic yards of material will have to be excavated. This will cost $93,500, provided no rock is encountered.

In order to give access to the wharves for vessels drawing the full depth that the new lock at Sault Ste. Marie is expected to give, a channel not less than 200 feet wide, with a depth of 22 feet, should be dredged along the dock line by the time the new lock is completed, and to that end work should be begun soon.

The principal shipments from Ashland are iron ore and lumber.

There has been expended during the year just closed $47,063.08, and the total amount expended under approved project to date is $185,145.42.

This work is in the collection district of Superior, Mich., Marquette, Mich., being the port of entry; nearest light-house, La Pointe. on Chequamegon Point, at entrance of Chequamegon Bay.

Recommendations.

For 637 feet extension to the breakwater	$30,000
For repairs and contingencies	20,000
For dredging	93,500
Total	143,500

Abstract of appropriations for improving harbor at Ashland, Wis.

By act of Congress—	
Approved August 5, 1886	$22,500
Of August 11, 1888	60,000
Approved September 19, 1890	60,000
Approved July 13, 1892	45,000
Total	187,500

Money statement.

July 1, 1893, balance unexpended	$49,417.66
June 30, 1894, amount expended during fiscal year	47,063.08
July 1, 1894, balance unexpended	2,354.58
July 1, 1894, outstanding liabilities	2,354.58
Amount (estimated) required for completion of existing project	119,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	143,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for repairs to brush and stone dike at Chequamegon Point, in Ashland Harbor, Wisconsin, received at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers. Opened July 31, 1893.

No.	Name and address of bidder.	For fascines in place (800 cords, more or less), per cord.	For stone in place (675 cords, more or less), per cord.	Total.
1	Davis, Davidson & Smith, Ashland, Wis	$7.50	$8.00	$11,400.00
2	Hugh Steele, Duluth, Minn	2.25	4.00	4,500.00
3	Edward Burton, Ashland, Wis	7.50	7.50	11,062.50

Contract awarded to Hugh Steele, with the approval of the Chief of Engineers, August 19, 1893.

Contract dated August 15, 1893. Work to be completed by October 31, 1893.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels (Chequamegon Bay, including Washburn and Bayfield, Wis.) for two years.

Year.	Number.	Average tonnage.
1892	7,104	No record.
1893	6,052	1,178

*Principal articles of exports and imports for 1893.**

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Iron ore	1,117,520	Coal	724,450
Pig iron	14,500	Oil	3,800
Stone, building	42,000	Salt, lime, and cement	56,740
Lumber	367,500	Merchandise and miscellaneous	201,859
Grain	222,600		
Flour	8,901	Total	986,849
Total	1,773,021	Total receipts and shipments	2,759,870

*Mr. Joe M. Chapple, of Ashland, Wis., is authority for this statement.

Comparative statement of receipts and shipments for seven years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	1,401,454	1890	2,816,924	1893	2,759,870
1888	1,357,472	1891	3,217,541		
1889	1,971,213	1892 †	4,267,097		

Arrivals and clearances of vessels for seven years.

Year.	Tons.	Year.	Tons.	Year.	Tons.
1887	892	1890	4,489	1893	6,052
1888	2.375	1891	4,099		
1889	3,171	1892 †	7,104		

† The years 1892 and 1893 include the ports of Washburn and Bayfield on Chequamegon Bay.

I I 6.

IMPROVEMENT OF HARBOR AT ONTONAGON, MICHIGAN.

In 1887 the Ontonagon River, which forms the harbor, had fairly deep water in it, but its mouth was obstructed by a bar which had but 7 feet depth over it. The project then adopted was to build parallel piers projecting into the lake on either side of the river's mouth, the expectation being that the current of the river would have sufficient force to maintain a depth between the piers of 12 feet or more. This expectation has not been fully realized, although the piers are nearly of the proposed length, the east pier being 2,315 feet in length and the west pier 2,675 feet.

It appears that the river during the freshets is heavily charged with sand and the bar at the entrance forms as fast as the piers are extended. The channel which the river is able to maintain through this bar is shifting and uncertain.

Unless the piers can be speedily extended into deep water, which, owing to the gradual slope of the lake bottom and consequent great expense, is hardly practicable, it does not appear advisable to carry the pier work any farther at present. The improvement of the harbor can probably be more economically pursued by dredging a channel through the bar each year, which will cost from $5,000 to $10,000 annually.

The total cost of the improvement to June 30, 1894, was $317,439.72. As a result of the improvement there was a channel with least depth of 16 feet.

The contract in force with George Taylor at the close of the last fiscal year, for repairs to the piers, was completed in August, 1893. Further repairs to the east pier will be necessary during the coming season.

A survey made in May, 1894, showed a still further shoaling in the channel. With the approval of the Chief of Engineers an open market agreement was made with Messrs. Williams, Daugherty & Upham to dredge out the channel to make it available for vessels drawing 12 feet of water. The work is nearly finished. The price to be paid is 18 cents per cubic yard, which is some 6 cents a yard less than the cost of the last dredging done in this harbor.

This work is in the collection district of Superior, Michigan. Nearest port of entry, Marquette, Mich. A light is shown on the outer end of the west pier at Ontonagon, Mich.

Abstract of appropriations for improving harbor at Ontonagon, Mich.

By act of Congress—	
Approved March 2, 1867	$97,600
Approved July 7, 1870	10,000
Approved June 23, 1874	23,000
Approved March 3, 1875	25,000
Approved August 14, 1876	15,000
Approved June 18, 1878	15,000
Approved March 3, 1879	17,000
Approved June 14, 1880	15,000
Approved March 3, 1881	20,000
Passed August 2, 1882	20,000
Approved July 5, 1884	15,000
Approved August 5, 1886	13,000
Passed August 11, 1888	12,500
Approved September 19, 1890	10,000
Approved July 13, 1892	20,000
Total	328,100

EXPENDITURES.

Amount expended under approved project to date	$317,439.72
Balance unexpended July 1, 1894	10,660.28

ESTIMATES.

Estimated amount required annually for preserving and maintaining (dredging) and repairs to piers	$10,000.00
Estimated amount required for renewal of superstructure of east pier	20,000.00
Total	30,000.00

Money statement.

July 1, 1893, balance unexpended	$20,219.78
June 30, 1894, amount expended during fiscal year	9,559.50
July 1, 1894, balance unexpended	10,660.28
July 1, 1894, outstanding liabilities	4,992.53
July 1, 1894, balance available	5,667.75
Amount (estimated) required for completion of existing project	33,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	33,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, ONTONAGON, MICH.

Not being able to obtain the statistics for the past five years, I append a report for 1893 without comparison with former years, but it is considerably greater than five years ago.

Arrivals and clearances of vessels, 1893.

Arrivals	[*] 77
Clearances	77

Principal articles of export and import.

	Tons.
Exports:	
Lumber	176,000
General merchandise	100
Total	176,100
Imports: General merchandise	2,000

I I 7.

IMPROVEMENT OF EAGLE HARBOR, MICHIGAN.

This harbor was improved in order to form one of the harbors of refuge for this shore of Lake Superior. The entrance to the small bay which forms the harbor was obstructed by a rock ledge having but 8½ feet of water over it at the shoalest part.

The project for its improvement was adopted in 1866, but was modified in succeeding years, so that, as carried out, it provided for a channel through the rocky ledge 130 feet wide and 14 feet deep, marked by two guiding cribs, one on each side of the channel.

This work was completed in 1879, and appears to meet the present demands of commerce.

The amount expended to June 30, 1894, was $95,238.08.

Nothing is required at present for the improvement or preservation of this harbor, as the funds available will probably be sufficient to keep the work in good condition for several years.

Modified estimate (see Report of Chief Engineers, 1876, II, 328; 1877, I, 98; II, 845)	$97,000
Appropriated	97,000

Name of harbor, Eagle Harbor, Michigan. Collection district, Superior, Mich. Nearest light-house, Eagle Harbor, Michigan.

Money statement.

July 1, 1893, balance unexpended	$2,286.33
June 30, 1894, amount expended during fiscal year	524.41
July 1, 1894, balance unexpended	1,761.92

COMMERCIAL STATISTICS, EAGLE HARBOR, MICHIGAN.

Vessels arriving and departing during 1893	42
Imports: Merchandise ......tons..	3,500

Statistics for previous years not obtainable.

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[*] In addition, there were a number of arrivals during the season of both steam and sailing vessels seeking refuge during heavy weather, and frequent arrivals of fishing and other tugs.

I I 8.

IMPROVEMENT AND OPERATING AND CARE OF WATERWAY FROM KEWEENAW BAY TO LAKE SUPERIOR, MICHIGAN.

This work was reported upon in the Report of the Chief of Engineers for 1892 (Appendix I I 1) under the title of "Portage Lake and Lake Superior canals, across Keweenaw Point, Michigan," but is locally known and referred to as the Portage Lake Ship canals.

A full account of the history of this work and its purchase by the United States is given in the above Annual Report.

The full report of the Board of Engineers, constituted in compliance with the provisions of the river and harbor act of August 5, 1886, is given in Ex. Doc. No. 105, Forty-ninth Congress, second session.

This Board submitted estimates for a navigable depth of 16 feet with a minimum width of 70 feet, to be obtained by dredging wherever required throughout the extent of the waterway, and in addition estimates for an increase, should the future needs of commerce demand it, of the navigable depth to 20 feet, with corresponding increase of width; also estimates of the cost required to provide (for commerce as well as refuge) enlarged and safe entrances from Keweenaw Bay and from the lake. The recommendations of the Board were approved by the Chief of Engineers and the Secretary of War.

The approved project, therefore, briefly stated, is as follows:

First. A 16-foot channel of 70 feet bottom width from bay to lake.

Second. A renewal of the canal revetments.

Third. A reconstruction of the piers at the Lake Superior entrance, and their extension to 30 feet depth of water.

Fourth. The extension of the pier at the Keweenaw entrance to a 20-foot depth of water.

Fifth. At the proper time hereafter to increase the channel depth to 20 feet, with a corresponding width, which should not be less than 100 feet.

In furtherance of this project, Congress, by act of July 13, 1892, appropriated $50,000 for dredging to 16 feet depth and 70 feet width and for repairs to existing revetments.

Most of this has been expended in dredging to a 16-foot depth and 70-foot width under a written agreement with James Pryor, of Houghton, Mich., the lowest bidder, and in repairs to the revetment at inner end of north revetment of the Upper Canal ($5,480.80).

Under authority of the river and harbor act of September 19, 1890, the Secretary of War allotted $11,647 for operating and care of canals and other works of navigation, to be applied to Portage Lake and Lake Superior canals, Michigan, for the fiscal year ending June 30, 1894.

The approved project for the expenditure of this allotment is to maintain a depth equal to the capacity of the present St. Marys Falls Canal, or in other words, an available depth of 14 feet with a width of 70 feet; to keep the existing channels well marked by lights and buoys; to keep a record of the vessels and their tonnage using the canal; to exercise the necessary care in enforcing regulations for the use of the canals; to make frequent surveys to determine changes, and to check up work done in dredging; to guard against encroachment on the legally established harbor lines, and to perform other work incidental to the operation and care of the canals. The amount allotted has been expended. An itemized statement is herewith submitted.

Owing to the poor condition of the existing revetments, permitting much material to be washed into the channels, and to the faulty design of the existing piers at the entrances and their failure to extend to a proper depth, more or less dredging will have to be done each year to maintain the improved channels. For this reason it would be advantageous for the United States to own its own plant.

Since the United States has taken charge the navigability of the waterway has been greatly bettered, due to the maintenance of an increased depth, to the easing off of sharp bends, the removal of detached rocks and lumps, and particularly to a better and more efficient system of lighting and buoyage.

At the close of the fiscal year, June 30, 1892, the available depth through the entire route was only 12.5 feet at a stage of 601.3 feet above sea level. We now have an available depth of 14 feet at a stage of 601.7 feet above sea level. A little more dredging at shoal places will give a navigable capacity equal to that at the St. Marys Falls Canal. It will require much more dredging, however, to get the width necessary to enable vessels to pass each other with safety, especially during strong winds.

Since the opening of navigation the present year no complaints have been received, and vessels loaded to 13.8 feet have had no difficulty in getting through.

The record of vessels and tonnage herewith submitted shows the great amount of commerce using this waterway and how important a link it is in the chain of lake navigation. With the completion of the 16-foot project, a very great increase in the use of this waterway may be confidently expected.

Attention is invited to the four maps printed in the last Annual Report.

Rules and regulations for the use of the canals were approved by the Secretary of War April 5, 1892. Owing to their being no legal penalties attending their violation great difficulty has been met with in enforcing them, especially the one relating to rafts. The navigation interests have suffered great inconvenience and some losses, due to the flagrant and apparently premeditated violation of the rules by the rafting interests. The most serious case was prosecuted in the U. S. court and a verdict against the Government was given, due to the absence of proper legislation defining the offense and inflicting a penalty.

Section 10 of the river and harbor act of September 19, 1890, inflicting a penalty of $5,000 fine or one year's imprisonment, or both, at the discretion of the court, should be extended to cover violations of the approved rules and regulations for the use of this waterway, otherwise it would be better to abolish them entirely.

APPROPRIATIONS.

(See p. 2166, Report of Chief of Engineers, 1892.)

Act of July 13, 1892	$50,000

RECOMMENDATIONS.

For operating and care, etc., for fiscal year ending June 30, 1895	$8,000
For continuing the improvement of the waterway to give a 16-foot depth and a 70-foot width	175,000
For providing a safe entrance from Lake Superior	850,000
For providing a safe entrance from Keweenaw Bay	220,000
Total	1,245,000

This work lies in the collection district of Superior. Nearest port of entry, Marquette, Mich. A light-house is at or near each entrance.

Money statement.

IMPROVEMENT.

July 1, 1893, balance unexpended	$38, 165. 52
June 30, 1894, amount expended during fiscal year	36, 553. 56
July 1, 1894, balance unexpended	1, 611. 96
July 1, 1894, outstanding liabilities	906. 45
July 1, 1894, balance available	705. 51
Amount (estimated) required for completion of existing project	1, 245, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	800, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

OPERATING AND CARE OF CANALS.

Amount allotted for fiscal year ending June 30, 1894	$11, 647. 00
June 30, 1894, amount expended during fiscal year	11, 647. 00
Amount allotted for fiscal year 1895	8, 000. 00

Abstract of proposals for dredging and repairs to pier revetment at Portage Lake ship canals, Michigan, received at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, opened July 14, 1893.

No.	Name and address of bidder.	For dredging sand and soft material (per cubic yard).	For dredging hardpan and stiff clay (per cubic yard).	Use of dredging plant in removing loose rock and detached bowlders (per hour).	For repairs to pier revetment (in total).
		Cents.	*Cents.*		
1	Williams, Daugherty & Upham, Duluth, Minn.	19	25	$11. 25	....
2	Charles S. Barker, West Superior, Wis	23	31	12. 50	....
3	James Pryor, Houghton, Mich	18½	24½	10. 00	$6, 581. 00
4	Carkin, Stickney & Cram, by D. D. Johnson, secretary, East Saginaw, Mich	23	48	15. 00	....
5	Francis L. McDonald, Duluth, Minn				5, 425. 00
6	William McCurdy, Houghton, Mich., and Thos. D. Mason, Hancock, Mich				6, 000. 00
7	Daniel W. Powell, Edward Mitchell, and John Mitchell, Marquette, Mich				5, 892. 64

Contract for dredging awarded to James Pryor, with the approval of the Chief of Engineers, August 5, 1893. Contract dated July 31, 1893. Work to be completed November 1, 1893.

Contract for repairs to pier revetment awarded to Francis L. McDonald, with the approval of the Chief of Engineers, August 5, 1893. Contract dated July 31, 1893. Work to be completed November 1, 1893.

COMMERCIAL STATISTICS.

Statistics of vessels passing through the canals during the calendar year 1893.

Bound up.	Number.	Net tonnage.
Steam	656	323, 569
Sail	212	111, 627

Statement of freight and passengers carried through the Portage Lake and Lake Superior canals during 1893.

Bound up.	Net tons.	Bound up.	Net tons.
Coal	254, 705	Limestone	9, 356
Flour	13	Miscellaneous merchandise	71, 836
Grain	1, 351	Copper	9, 864
Manufactured iron	8, 946		
Salt	4, 598	Passengers .... number	14, 592

RECAPITULATION.

	1893.		1892.	
	Total.	Upper canal.	Total.	Upper canal.
Number of vessels	868	473	902	454
Net tonnage	435, 196	292, 990	451, 218	309, 171
Freight .... tons	360, 669	192, 438	357, 773	196, 937
Passengers	14, 592	9, 430	16, 963	10, 453

Bound down.	Number.	Net tonnage.
Steam	449	184, 532
Sail	91	49, 782

Statement of freight and passengers carried through the Portage Lake and Lake Superior canals during 1893.

Bound down.	Net tons.	Bound down.	Net tons.
Copper	54, 548	Iron ore	400
Corn	120	Lumber	79, 644
Flour	21, 542	Miscellaneous merchandise	11, 336
Building stone	1, 180		
Pig iron	3, 189	Passengers .... number	12, 492

RECAPITULATION.

	1893.		1892.	
	Total.	Upper canal.	Total.	Upper canal.
Number of vessels	540	186	568	185
Net tonnage	234, 314	108. 952	213. 845	90, 125
Freight .... tons	171, 959	98, 602	138, 515	70, 619
Passengers .... number	12, 492	8, 895	13, 130	6, 587

Statistics of tugs passing through the canals during the year 1893.

Bound up.	Total.	Bound down.	Total.
Trips .... number	489	Trips .... number	468
Net tonnage	17, 001	Net tonnage	15, 352
Vessels .... number	73	Vessels .... number	31
Scows .... do	152	Scows .... do	145
Rafts .... do	29	Rafts .... do	73
Booms .... do	54	Booms .... do	30
Logs .... M	2, 935	Logs .... M	19, 033
Lumber .... M	570	Lumber .... M	283
Timber .... M	4, 985	Timber .... M	16
Cord wood .... cords	580	Cord wood .... cords	115
Building stone .... tons	9, 762	Building stone .... tons	196
Miscellaneous merchandise .... do	713	Miscellaneous merchandise .... do	713
Coal .... do	200	Coal .... do	100
Sand .... do	212	Copper .... do	2, 567
Railroad ties .... number	6, 000		

Local business of tugs in Portage Lake during 1893.

Bound up.	Total.	Bound down.	Total.
Trips .... number..	679	Trips .... number..	667
Net tonnage........	11,671	Net tonnage........	11,548
Vessels .... number..	1	Vessels .... number..	1
Scows........ do....	1,161	Scows .... do....	1,093
Rafts .... do....	55	Rafts........ do....	13
Booms .... do....	8	Booms .... do....	41
Logs .... M..	11,626	Logs .... M..	1,610
Lumber .... do....	4,055	Lumber .... do....	1,750
Timber........ do....	1,500	Timber........ do....	8,890
Cord wood........ cords..	13,989	Cord wood........ cords..	12,695
Miscellaneous merchandise...... tons..	265	Miscellaneous merchandise..... tons..	1,172
Hay .... do....	390	Copper........ do....	1,070
Coal........ do....	80	Poles .... number..	21,000
Empty barrels........ number..	250	Hay .... tons..	690
Lime .... barrels..	50	Railroad ties........ number..	35,300
		Charcoal .... bushels..	21,800
		Lime .... barrels..	225
		Cement........ do....	45

Statistics of vessels passing through the upper canal (Portage Lake ship canals) during the year 1893.

Bound up.	Total.	Bound down.	Total.
Steam	327	Steam	167
Net tonnage........	224,337	Net tonnage........	100,017
Sail........	146	Sail........	19
Net tonnage	68,662	Net tonnage........	8,935
Cargo .... tons..	192,438	Cargo .... tons..	98,692
Passengers .... number..	9,430	Passengers .... number..	8,895

RECAPITULATION (PORTAGE LAKE SHIP CANALS).

Bound up and down.	1892.	1893.	Increase +. Decrease—.
Total number of vessels........	1,470	1,408	—62
Total net tonnage........	665,063	669,510	+4,447
Total freight........ tons..	496,288	532,628	+36,340
Total passengers........ number..	30,093	27,084	—3,009

The following principal lines of steamers used the canals during the season of 1893:

Lake Michigan and Lake Superior Transportation Company, Chicago, Ill.......	5
Western Transit Company, Buffalo, N. Y........	8
Anchor Line, Erie, Pa........	6
Crescent Transportation Company, Detroit, Mich........	6
Union Transit Company, Buffalo, N. Y........	3

During the season of 1894 there were some changes, the lines of steamers being as follows:

Lake Michigan and Lake Superior Transportation Company, Chicago, Ill.......	5
Western Transit Company, Buffalo, N. Y........	10
Anchor Line, Erie, Pa........	8
Crescent Transportation Company, Detroit, Mich........	6
Union Transit Company, Buffalo, N. Y........	2
Duluth and Ogdensburg Transportation Company, Detroit, Mich........	3

These are considered the regular transportation lines. During the season of 1894 many large steamers of other lines have made trips through these canals successfully, and a great part of the freighting business of these canals is done by steam barges with from one to three vessels in tow; these steam barges now being able to take a tow of three heavily loaded vessels through Portage River without trouble. There is also a large business done by tugs, mostly owned in this vicinity, in towing vessels, rafts of logs and timber, and scows loaded with wood, building stone, lumber, hay, etc.

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation (indefinite), act of July 5, 1884, applied to Portage Lake and Lake Superior canals.

Date.	No. of voucher.	Name.	Designation.	Amount.
1893.				
Aug. 2	1	Sundry persons	Services, July, 1893	$268.33
2	2	Sam S. Robinson	Hire of tug	133.00
2	3	J. B. Sturgis	Rent	19.00
3	4	L. Hennes & Co.	Supplies	21.53
9	5	Maj. Clinton B. Sears, Corps of Engineers.	Mileage	42.72
25	6	Geo. B. Carpenter & Co	Purchase winch	32.00
31	1	J. B. Sturgis	Office rent	19.00
31	2	Hired men	Services	304.00
Sept. 1	1	Chas. J. Hodge	Repair work	11.25
6	2	L. Hennes & Co	Supplies	24.14
13	3	F. W. Kroll	Stationery, etc	4.90
30	4	J. B. Sturgis	Office rent	19.00
30	5	Hired men	Services	407.00
Oct. 6	1	Brown & Gray	Supplies and repairs	20.52
6	2	Sam S. Robinson	Hire of tug	148.00
6	3	L. Hennes & Co	Purchase supplies	10.33
31	1	Brown & Gray	Repairs	4.87
31	2	J. B. Sturgis	Office rent	19.00
31	3	Payroll	Sundry persons, services	381.00
Nov. 4	1	L. Hennes & Co	Supplies	9.00
30	2	Sam S. Robinson	Tug hire	104.00
Dec. 1	1	Pay roll	Services	284.00
1	2	L. Hennes & Co	Supplies	4.05
1	3	F. W. Kroll	......do	2.25
2	4	James Pryor & Son	Lumber	11.87
2	5	J. B. Sturgis	Office rent November, 1893	19.00
18	6	F. W. Kroll	Office furniture	3.50
31	7	J. B. Sturgis	Office rent, December, 1893	19.00
31	8	Pay roll	Services	343.67
1894.				
Jan. 31	9	J. B. Sturgis	Office rent, January, 1894	19.00
31	10	Sundry persons (pay roll)	Services, January, 1894	277.00
Feb. 28	9	J. B. Sturgis	Office rent, February, 1894	19.00
28	11	Pay roll	Sundry persons, services	277.00
Mar. 26	3	E. F. Barker	Rubber stamp	.75
31	11	J. B. Sturgis	Office rent	19.00
31	12	Sundry persons (pay roll)	Services	277.00
Apr. 14	4	Keuffel and Esser Co., Hermann Esser, treasurer.	Angle mirror	8.50
26	6	Maj. Clinton B. Sears, Corps of Engineers.	Mileage	42.72
30	17	J. B. Sturgis	Office rent	19.00
May 3	(pt) 1	(pt) pay roll	Services (April)	128.00
3	2	Sam S. Robinson	Tug hire	26.00
3	3	L. Hennes & Co	Supplies	33.70
8	4	F. W. Kroll	Stationery	1.30
9	6	Harvey C. Beeson	Marine directory	5.00
31	22	J. B. Sturgis	Rent	19.00
31	(pt) 1	G. A. Marr	Services (April)	200.00
31	26	Pay roll	Services (May)	511.00
June 2	2	Sam S. Robinson	Tug hire	138.00
2	3	Brown & Gray	Supplies and repairs	36.15
2	4	James Pryor	Supplies, etc	61.00
2	5	L. Hennes & Co	......do	14.97
4	(pt) 7	James Pryor	Dredging	8,000.00
19	(pt) 7	......do	......do	1,219.29
19	24	......do	Chain	39.75
19	25	Joseph Croze	Lumber	14.00
25	35	Brown & Gray	Supplies	1.75
25	36	L. Hennes & Co	......do	19.03
25	37	James Burt	......do	2.50
29	38	Maj. Clinton B. Sears, Corps of Engineers.	Mileage	42 72
30	48	Sundry persons	Services	318.67
30	47	James R. Dee, manager	Telephone service	19.85
30	46	J. B. Sturgis	Rent	19.00
30	52	Sam S. Robinson	Tug hire	125.00
30	53	James Pryor	Dredging	1,999.12
		Total		11,647.00

I I 9.

IMPROVEMENT OF HARBOR AT MARQUETTE, MICHIGAN.

The project for the improvement of this harbor was adopted in 1868. It contemplated the erection of a breakwater composed of timber cribs ballasted with rock, and extending from the shore into the bay a distance of 2,000 feet. This breakwater was completed, practically as proposed, in 1875.

In consequence of the increasing shipments of iron ore from this port, the area protected proved to be too small for the needs of the shipping engaged in this commerce, and it became necessary to extend the breakwater.

Provision was made for the commencement of this extension in the river and harbor bill of August 11, 1888.

The approved project of extension limits it to 1,000 feet. At date of last annual report 900 feet of this extension had been finished, or contracted for. Of this, 600 feet has been built under the contract with Powell & Mitchell in force at the close of the last fiscal year.

After due advertisement the contract for building the last 100 feet of the breakwater was awarded to Powell & Mitchell, the lowest bidders. This work is now nearly completed. This will give the breakwater its full length of 3,000 feet, as called for in the project.

The superstructure of the portion of the breakwater commenced in 1866 and finished in 1875 has been extensively repaired, but is nevertheless not as secure as is to be desired. Much of the timber has already been in place several years longer than the usual life of timber in this climate, and the time is short, if it has not already arrived, when this timber work must be replaced by more permanent material.

A project for a concrete superstructure was prepared, and was approved February 27, 1890. This superstructure is estimated to cost $232,936.71, of which sum $110,000 could be expended judiciously in one year.

Harbor lines were established by the honorable Secretary of War in January, 1889, and a reconsideration of the subject occurred upon the application of the Duluth, South Shore and Atlantic Railway Company. Pending the action of the honorable Secretary of War upon this new motion, the railroad company extended the ore dock as prayed for in the petition. I am not advised as to the final action upon the railroad company's petition, but no complaints from interested citizens of Marquette or from owners or masters of vessels visiting this port have so far been received regarding these extensions beyond the harbor lines, from which it is to be inferred that the encroachment is rather viewed as advantageous to all concerned.

Recommendations for next year.

For concrete superstructure to old work	$110,000
General repairs	15,000
Total	125,000

Abstract of appropriations for improving harbor at Marquette, Mich.

By act of Congress—	
Approved March 2, 1867 (allotment)	$85,000
Approved April 10, 1869 (allotment)	26,730
Approved July 11, 1870	25,000
Approved March 3, 1871	60,000
Approved June 10, 1872	50,000
Approved June 23, 1874	15,000

By act of Congress—

Approved March 3, 1875	$15,000
Approved March 3, 1873	15,000
Approved August 14, 1878	2,000
Approved June 18, 1878	2,000
Approved March 3, 1879	1,500
Approved June 14, 1880	1,000
Passed August 2, 1882	16,000
Approved July 5, 1884	5,000
Approved August 5, 1886	10,000
Of August 11, 1888	25,000
Approved September 19, 1890	40,000
Approved July 13, 1892	80,000
Total	474,230

Name of harbor, Marquette Harbor, Michigan. Collection district, Marquette, Mich. Nearest light-house, Marquette, Mich.

Money statement.

July 1, 1893, balance unexpended	$71,775.87
June 30, 1894, amount expended during fiscal year	60,812.51
July 1, 1894, balance unexpended	10,963.36
July 1, 1894, amount covered by uncompleted contracts	5,745.00
July 1, 1894, balance available	5,218.36
Amount (estimated) required for completion of existing project	257,936.71
Amount that can be profitably expended in fiscal year ending June 30, 1896	134,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for extension to breakwater at Marquette, Mich., received at Duluth, Minn., by Maj. Clinton B. Sears, Corps of Engineers, opened May 18, 1894.

No.	Name and address of bidder.	For cribs and superstructure, 100 feet long, including filling, sinking, and riprapping (per running foot).	Total.
1	Francis L. McDonald, Duluth, Minn	$64.85	$6,485.00
2	William McLeod, Manistee, Mich	62.50	6,250.00
3	George Taylor, Duluth, Minn	69.00	6,900.00
4	Daniel W. Powell, Edward Mitchell, and John Mitchell, of Marquette, Mich	57.45	5,745.00

Contract awarded to Powell & Mitchell, with the approval of the Chief of Engineers, June 2, 1894.

Contract dated May 28, 1894. Work to be completed by October 15, 1894.

COMMERCIAL STATISTICS, MARQUETTE, MICH.

Year.	Arrivals.	Clearances.	Tonnage.
1892	782	788	1,474,002
1893	661	661	594,900

Steam	441
Sail	220

Principal articles of export and import.

Articles.	Tons.	Articles.	Tons.
EXPORTS.		IMPORTS.	
Iron ore	1,086,934	Coal	112,056
Pig iron	15,360	Oil	141
Lumber	46,648	Brick and cement	70
		General merchandise	4,000
Total	1,148,942		
		Total	116,267

Vessel tonnage.

Year.	Tonnage.	Average tonnage.
1893	594,900	900
1892	1,474,002	941
Decrease	897,102	41

Crescent Transportation Company, of Buffalo, N. Y., is a new line of boats doing business at this port.

I I 10.

IMPROVEMENT OF HARBOR OF REFUGE AT GRAND MARAIS, MICHIGAN.

The harbor of Grand Marais, Mich., was only accessible for vessels drawing less than 9 feet. Once within the bay there is ample depth to float the largest vessels. As a harbor of refuge it is of pressing importance to the shipping navigating the lakes in this vicinity, as the many wrecks in this neighborhood bear witness.

The project for the improvement of this harbor was adopted in 1881, and has for its object the creation of a safe entrance into the bay for vessels of the largest size. The entrance channel is 175 feet in width, protected by crib piers on either side. The west pier is now 1,406 feet long, including 100 feet of pile dike, and the east pier is 1,153 feet long, including 100 feet of pile dike.

A channel 150 feet wide and 17 feet deep was dredged out between the piers in 1889.

An examination made in June, 1890, showed considerable shoaling, and in 1891 it was again dredged, this time to a width of 175 feet and a least depth of over 17 feet. A partial survey made in June, 1893, shows a shoaling to 14 feet, principally opposite the portion of the west pier which extends beyond the east pier, so that with any swell on it will not be safe to try to bring in a vessel of more than 12 feet draft.

An examination made in June, 1894, shows that there is a least depth of 15.5 feet along the channel, and this is, as before, opposite the west pier where it extends beyond the east pier.

Allowing for 1 foot higher water this year than last, shows a gain of .5 foot in depth, and is due, probably, to the 300 feet of extension to the east pier, built last season under the contract with Powell & Mitchell in force at the close of the last fiscal year.

To complete the work according to the approved project, 400 feet remain to be added to the west and 600 feet to the east pier. If the extension of the piers continues with reasonable celerity, probably a channel dredged to full 17 feet will not be obliterated, but will preserve a depth sufficient to revive the commercial interests of this place, which are held in abeyance at present for lack of this essential.

Large lumbering interests lie contiguous to this harbor, which would make it a shipping point in the event of there being a sufficient depth of water in the channel to accommodate the vessels engaged in such business, and I think that it would not be long after obtaining a navigable channel into it before the harbor would claim other distinctions than that of a harbor of refuge.

The Manistique Railroad has been completed to a dock in the harbor; at the other end it connects with the Duluth, South Shore and Atlantic Railroad. At Grand Marais, a sawmill, long out of use, is being put in condition to work, and a shingle mill is about to be built.

The entry between the piers is an artificial one, and was dredged through a long sand spit. The piers cut off the supply of sand from the spit to the east, and this portion is rapidly wasting away under the action of the currents and waves. It may prove necessary before many years to close the old natural entry entirely, in order to preserve the integrity of the harbor. A survey upon which to base a study of this matter will soon be undertaken.

Both piers should be carried out to 20 feet depth of water before any more dredging is done. This will require 600 feet of extension to the east pier and 400 to the west pier, and will require further appropriations.

Original estimate (see Report of Chief of Engineers, 1881, p. 2053)	$450,000
Appropriated	261,250

This work is in the collection district of Superior, Mich.; nearest port of entry, Marquette, Mich.; nearest light-house, Big Sable, Mich.

Abstract of appropriations for improving harbor of refuge at Grand Marais, Mich.

By act of Congress—	
Approved June 14, 1880	$10,000
Approved March 3, 1881	20,000
Passed August 2, 1882	40,000
Approved July 5, 1884	35,000
Approved August 5, 1886	26,250
Of August 11, 1888	50,000
Approved September 19, 1890	50,000
Approved July 13, 1892	30,000
Total	261,250

Money statement.

July 1, 1893, balance unexpended	$33,675.07
June 30, 1894, amount expended during fiscal year	27,639.62
July 1, 1894, balance unexpended	6,035.45
Amount (estimated) required for completion of existing project	188,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Arrivals and clearances of vessels at Grand Marais, Mich.

Vessels.	Arrivals.	Clearances.
1892:		
Steamers	155	155
1893:		
Steam, 187 (tonnage, 26,645) Sail, 11 (tonnage, 10,000)	198	197

Principal articles of export and import.

	Tons.
Exports:	
Fish	2,200
Wood	1,250
Imports:	
Coal	22,000
General merchandise	3,000
Lumber	4,500
Stone	2,500
Total	35,450

Receipts and shipments for seven years.

Year.	Tons.	Year.	Tons.
1887	1,910	1891	1,356
1888	6,270	1892	5,020
1889	8,686	1893	35,450
1890	9,405		

New lines of transportation.

Lake Superior Transit and Fish Company, one steamer between Sault Ste. Marie, Mich., and Grand Marais, Mich.

Connable Fishing Company, one steamer between Grand Marais and Marquette, Mich.

I I II.

MODIFICATION OF HARBOR LINES IN SUPERIOR BAY, WISCONSIN.

OFFICE OF CITY ENGINEER, CITY OF SUPERIOR,
West Superior, Wis., March 12, 1894.

DEAR SIR: Inclosed please find map* of proposed changes in the dock lines of Superior Bay, accompanied by a copy of a resolution passed by the council, which will explain itself.

Yours, very truly,

A. T. THOMAS,
City Engineer.

Maj. CLINTON B. SEARS,
Corps of Engineers, U. S. A.

[First indorsement.]

U. S. ENGINEER OFFICE,
Duluth, Minn., March 13, 1894.

Respectfully submitted to the Chief of Engineers, U. S. Army, through Col. O. M. Poe, Corps of Engineers, Division Engineer, with recommendation for favorable consideration.

The present dock lines were established by the War Department September 8, 1890. (*See* Report of Chief of Engineers, 1891, p. 2516, etc.)

Since their establishment, large elevator and flour mill interests have developed along the water front at Old Superior, much beyond what was anticipated at the time of establishment.

The proposed change is a compromise between the extravagant demands of the elevator and mill men and my unwillingness to recommend any change whatever.

The new line is well within the channel already dredged by the United States, so that there will be no encroachment on said channel, and the space taken in will enable established elevator and mill interests to do business to better advantage, as they can not gain ground to the rear on account of the railroad which runs along parallel and close to the natural shore.

---

* Omitted.

The change from the point opposite Stinson avenue to the mouth of the Nemadji is, in my opinion, an advantageous one, as it does away with an awkward reentrant angle and leaves a better line of ingress and egress for the entry and for any slips that may be hereafter constructed along this portion of the water front.

CLINTON B. SEARS,
Major, Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., March 16, 1894.

Respectfully forwarded to the office of the Chief of Engineers.

In my opinion the proposed change in the dock line, as represented upon the accompanying tracing, would improve it. I therefore recommend its approval by the proper authority.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
March 19, 1894.

Respectfully submitted to the Secretary of War.

The existing harbor lines on Superior Bay were established by the Secretary of War, September 8, 1890. The city of Superior now requests approval of a change in the established lines, which change is shown in red on the accompanying tracing.

Inviting attention to the favorable reports of Maj. Sears, the district engineer, and Col. Poe, the Division Engineer, in first and second indorsements hereon, I recommend that the proposed modification be approved and that the Secretary place his approval on the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

NOTE.—The harbor lines shown on the map were approved by the Secretary of War, March 21, 1894.

RESOLUTION OF CITY OF SUPERIOR, WIS.

Resolved, That it is the sense of the city council of the city of Superior that it is to the interest of Superior that the dock lines on Superior Bay be extended as follows:

Beginning at a point at the angle in the established dock line on Superior Bay, opposite lot 6, on Connors Point; thence running southeasterly to a point 50 feet northeast of the established dock line opposite the center line of Stinson avenue produced; thence running easterly to the west end of the 200-foot radius curve of the present established dock line near the mouth of the Nemadji River; thence running in an easterly direction to the east end of the said curve.

Further resolved, That a copy of this resolution, certified by the city clerk, and a map of the proposed change, certified by the city engineer, be sent to Maj. Sears, Corps of Engineers, U. S. Army, requesting his approval, and that he forward the same to the Secretary of War for his official approval.

Passed and adopted March 6, 1894.
Approved March 9, 1894

E. C. KENNEDY.
Mayor.

Attest:

GEORGE PETERSON,
City Clerk.

APPENDIX J J.

IMPROVEMENT OF RIVERS AND HARBORS ON WESTERN SHORE OF LAKE MICHIGAN.

REPORT OF MAJ. JAMES F. GREGORY, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. **Manistique Harbor, Michigan.**
2. **Cedar River Harbor, Michigan.**
3. **Menominee Harbor, Michigan and Wisconsin.**
4. **Menominee River, Michigan and Wisconsin.**
5. **Oconto Harbor, Wisconsin.**
6. **Pensaukee Harbor, Wisconsin.**
7. **Green Bay Harbor, Wisconsin.**
8. **Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.**
9. **Operating and care of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.**
10. **Harbor of refuge at entrance of Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.**
11. **Ahnapee Harbor, Wisconsin.**
12. **Kewaunee Harbor, Wisconsin.**
13. **Two Rivers Harbor, Wisconsin.**
14. **Manitowoc Harbor, Wisconsin.**
15. **Sheboygan Harbor, Wisconsin.**
16. **Port Washington Harbor, Wisconsin.**
17. **Harbor of refuge at Milwaukee Bay, Wisconsin.**
18. **Milwaukee Harbor, Wisconsin.**
19. **Racine Harbor, Wisconsin.**
20. **Kenosha Harbor, Wisconsin.**
21. **Waukegan Harbor, Illinois.**
22. **Fox River, Wisconsin.**
23. **Operating and care of locks and dams on Fox River, Wisconsin.**
24. **Removing sunken vessels or craft obstructing or endangering navigation.**

HARBOR LINES.

25. Oconto Harbor, Wisconsin.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., July 7, 1894.

GENERAL: I have the honor to transmit herewith annual report for the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

J J 1.

IMPROVEMENT OF MANISTIQUE HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Lake Michigan into the mouth of the Manistique River, where the harbor of Manistique is situated.

Project.—The original project, adopted in 1880, provided for the excavation of about 20,000 cubic yards of material to complete a channel 150 feet wide and 12 feet deep between the piers constructed by local enterprise at the mouth of the Manistique River.

Present works.—No construction work was done by the United States Government. The piers were built and are still owned by private parties.

Depth of water.—Originally there was a depth of 7 feet, which was increased to 10 feet before any appropriation had been made by the Government. A survey made May 12, 1892, showed at that date a channel, between the piers, of navigable width with a depth of 13 feet. The outer bar was not clearly defined, but the ruling depth over it appeared to be about 11 feet. Dredging by private enterprise was in progress, increasing the depth of water over the outer bar.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1894.

Remarks and recommendations.—The only work by the United States at this harbor has been the removal of 11,780 cubic yards of material in 1880, under a contract with the Chicago Lumbering Company.

In October, 1880, a survey of the harbor showed that the direction of the piers lay across the natural channel. The company which had built the piers, and had also the contract for dredging, found it necessary at this time to renew about 330 feet of the west pier, which had been washed away. The superintendent of the company was notified by the officer in charge, Maj. H. M. Robert, that the pier lines would have to be rectified to conform to the natural channel. The company declined to comply with this demand, and their contract, which had been extended from December, 1880, to June 1, 1881, was annulled. There have been no operations at this harbor since, and no money is asked for its improvement.

Estimated cost (see Report Chief of Engineers, 1880, p. 1931)	$6,000.00

APPROPRIATIONS.

Act of—	
June 14, 1880	$5,000.00
March 3, 1881	1,000.00
Total	6,000.00

Money statement.

July 1, 1893, balance unexpended	$2,499.40
June 30, 1894, amount expended during fiscal year	71.00
July 1, 1894, balance unexpended	2,428.40

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. W. H. Hill, secretary Chicago Lumbering Company.]

Name of harbor, Manistique, Mich. Collection district, Superior, Mich. Nearest light-house, Poverty Island, Michigan.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	294	110,284	294	110,284
Sail	172	48,085	172	48,085
Total	466	158,369	466	158,369

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Exports.	Tons.	Imports.	Tons.
Barrels (oil, empty)	33	Apples	21
Beer	10	Beans	8
Cattle	4	Beer	14
Corn	4	Brick	1,278
Fish	57½	Cattle	30
Hides	7½	Cement	145
Iron, pig	6,796	Coal and coke	3,444
Lath	5,137	Corn	22
Lime and cement	10	Flour	95
Lumber	127,500	Hay	558
Merchandise (general)	135	Iron and steel	47
Oats	48	Merchandise (general)	1,391
Pickets (fence)	2,253	Oats	326½
Posts (fence)	299	Oil	225
Shingles	919½	Pork and beef	64½
Ties (R. R.)	2,030	Salt	101
Total	147,243½	Total	7,700
Total approximate value	$1,385,000	Total approximate value	$310,000

NOTE.—In regard to the exports and imports by all ways of transportation, Mr. W. H. Hill, secretary Chicago Lumbering Company, states as follows:

I can not give you the amounts by railway, as the station agent does not care to go through the old bills. Our own business by rail was:

EXPORTS.

	Tons.
Lime	13,300
Pig iron	20,000
Total	33,300
Total approximate value	$356,000

IMPORTS.

Flour	559
Oats	160
Hay	400
Iron ore	20,000
Coal	200
Merchandise (general)	600
Total	21,919
Total approximate value	$128,500

This is approximate, as we do not keep the close record by rail that we do by water.

J J 2.

IMPROVEMENT OF CEDAR RIVER HARBOR, MICHIGAN.

Object.—To secure a navigable channel from Green Bay into Cedar River, where the harbor of Cedar River is located.

Project.—The original project, adopted in 1883, provided for the construction of two parallel piers 200 feet apart, extending from the mouth of Cedar River to the 16-foot contour in Green Bay, and dredging a channel between them 14 feet deep; also removing an outer shoal by dredging to a depth of 15 feet.

A modification of this project, approved in 1884, provided for continuing the piers in a direct line with the part already built, instead of at an angle, as originally proposed.

Present works.—Pile piers lined with sheet piling: (1) east pier, 754 feet in length, 16 feet wide; (2) west pier, 301 feet in length, 16 feet wide. All were built in 1883-1885 and are in good condition.

Depth of water.—Originally 8 to 10 feet; obstructed by a 3-foot bar in front of the mouth.

A survey made in April, 1894, showed a narrow channel with a governing depth of 14 feet.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1894.

Remarks and recommendations.—Work was suspended at this harbor in November, 1885, and has not been resumed by the United States since that date. It is reported that some dredging was done by private enterprise in 1891 and 1892.

In view of the small amount of commerce likely to be benefited by its completion, no appropriation for continuing the improvement has been recommended since 1885.

Original estimate (see Report of Chief of Engineers, 1882, p. 2121)	$138,000

APPROPRIATIONS.

Act of—	
August 2, 1882	$15,000
July 5, 1884	15,000
Total	30,000

Money statement.

July 1, 1893, balance unexpended	$1,895.07
June 30, 1894, amount expended during fiscal year	86.04
July 1, 1894, balance unexpended	1,809.03
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	108,000.00

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. Jesse Spalding, president of Spalding Lumber Company.]

Name of harbor, Cedar River, Mich.; collection district, Superior, Mich.; nearest light-house, on north pier-head, Cedar River Harbor, Michigan.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	215	50,260	215	50,260
Sail	200	62,500	200	62,500
Total	415	112,760	415	112,760

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.
EXPORTS.	*Tons.*
Bark (tan)	42
Fish	15
Hides	5½
Lath	1, 501½
Lumber	44, 812½
Pickets (fence)	150
Poles (telegraph)	146
Posts (fence)	3, 230
Pulp wood	150
Shingles	2, 175
Ties (railroad)	10, 010
Total	62, 237½
IMPORTS.	
Apples	15
Beer	115
Brick	20
Butter	3
Cattle	78
IMPORTS—continued.	*Tons.*
Coal and coke	126
Corn	56
Eggs	0½
Flour	172
Hay	475
Lime and cement	14½
Merchandise, general	40
Mill stuffs	15
Oats	282
Oil	55
Pork and beef	33
Potatoes	14
Provisions	31
Salt	15
Saw logs	3, 600
Total	5, 160
Total approximate value	$176, 000

J J 3.

IMPROVEMENT OF MENOMINEE HARBOR, MICHIGAN AND WISCONSIN.

Object.—To secure a navigable channel from Green Bay into the Menominee River, where the harbor of Menominee is situated.

Project.—The original project, adopted in 1871, provided for the construction of two parallel piers 400 feet apart, extending from the mouth of the river to the 15-foot contour in Green Bay, and dredging a channel between them 14 feet deep. In 1874 it was decided to extend the piers to the 16-foot contour.

Present works.—(1) North pier, 1,854 feet in length, consisting of 585 feet of slab pier 20 feet wide; 609 feet of pile pier, 481 feet of the same having a width of 14 feet and 128 feet a width of 18 feet; 660 feet of cribs, 610 feet with a width of 20 feet, and 50 feet with a width of 24 feet. (2) South pier, 2,710 feet in length, consisting of 1,900 feet of pile pier, 1,804 feet having a width of 14 feet and 96 feet a width of 18 feet, and 810 feet of cribs 20 feet wide.

The pile piers were built in 1871–1874 and the cribs 1876–1884. The cribs are in good condition. The north pile pier was rebuilt above the water line in 1889 and is in good condition. The south pile pier is much decayed and should be rebuilt above the water line.

Depth of water.—Originally 4 feet. The channel now is 200 feet wide and 16 feet deep the full length of the harbor piers, and connects the 16-foot channel in the Menominee River with water of the same depth in Green Bay.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1894.

Remarks and recommendations.—The full amount of the original estimate for the improvement of this harbor has been appropriated and the object sought is obtained.

Arrangements have been made, to go into effect early in July, 1894, for a line of steamers, each carrying 24 loaded freight cars, to ply across Green Bay and Lake Michigan, between Menominee and Frankfort, thereby establishing, in conjunction with existing railways, a new through route of transportation between the Atlantic seaboard and the West.

Of the 1,900 linear feet of the south pile pier, built in 1871–1874, at least 1,000 linear feet should be rebuilt above the water line without delay. A section of this pier covering about 315 linear feet was badly damaged by a freshet, the line of piling forming its channel face being undermined, rendering a new line of piling necessary. Some damage of the same character has also been caused by the working of the wheels of heavily laden propellers that grounded near the pier.

An appropriation of $15,000 is recommended to make the repairs now needed to this pier.

Original estimate (see Report of Chief of Engineers, 1874, Part I, p. 139)	$212,000

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	March 3, 1881	$12,000
June 10, 1872	25,000	August 3, 1882	15,000
March 3, 1873	25,000	July 5, 1884	10,000
June 23, 1874	25,000	August 5, 1886	3,000
March 3, 1875	25,000	August 11, 1888	9,000
August 14, 1876	8,000	Miscellaneous receipts credited to appropriations	62
June 18, 1878	10,000		
March 3, 1879	10,000		
June 14, 1880	10,000	Total	212,062

Money statement.

July 1, 1893, balance unexpended	$132.32
July 1, 1894, balance unexpended	132.32
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	15,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of the sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by John Joiner, deputy collector of customs.]

Name of harbor, Menominee, Michigan and Wisconsin; collection district, Superior, Mich.; nearest light-house, Menominee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	611	175,760	620	178,665
Sail	395	68,226	414	82,168
Total	1,006	243,986	1,034	260,833

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.		IMPORTS—continued	
	Tons.		*Tons.*
Coal	25	Brick	2,236
Fish	25	Butter	89
Lath	1,064	Coal	11,305
Lumber	329,211	Eggs	5
Pickets, fence	585	Hay	945
Sand	150	Iron	129
Shingles	902	Merchandise, general	2,506
		Oil	35
Total	331,962	Pork and beef	155
		Posts, fence	228
Total approximate value	$2,700,000	Potatoes	6
		Salt	667
IMPORTS.		Stone	1,155
		Wood	1,275
Agricultural implements	60		
Apples	82	Total	20,878

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by B. H. Auderly, deputy collector of customs.]

Name of harbor, Marinette, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, on north pier head, Menominee, Mich.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	283	90,316	282	89,958
Sail	453	128,046	453	128,037
Total	736	218,362	735	217,995

Principal articles of export and import.

BY WAY OF HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS—continued.	*Tons.*
Fish	400	Fish	475
Lath	2,396½	Hay	203
Lumber	346,873½	Iron and steel	14
Shingles	877½	Merchandise, general	6,000
		Oats	8
Total	350,547½	Oil	337½
		Potatoes	7
IMPORTS.		Salt	75
Brick	316	Stone	2,296
Butter	0½	Wood	872½
Cheese	1		
Coal and coke	31,701	Total	42,308
Eggs	1½		

J J 4.

IMPROVEMENT OF MENOMINEE RIVER, MICHIGAN AND WISCONSIN.

Object.—The formation of a channel of navigable width 16 feet deep from Green Bay to N. Ludington Company's mill, Marinette, Wis., a distance of about 2 miles.

Project.—The original project, approved October 2, 1890, for the expenditure of $54,000, appropriated by act of September 19, 1890, was for dredging a channel 200 feet wide and 16 feet deep from Green Bay up the Menominee River as far as available funds would admit.

The modified project, approved July 26, 1892, provides for reducing the width of the upper end of the channel to 100 feet for a distance of about 2,600 feet.

Present works.—The piers of the Menominee Harbor improvement render construction works unnecessary for the Menominee River improvement.

Depth of water.—The lower section of the channel, 200 feet wide and about 9,300 feet long, has been dredged to the required depth of 16 feet, with the exception of about 800 linear feet, where the width varies from 160 to 190 feet.

A shoaling of from 1 to 2 feet has since occurred in places, but there is a depth of 16 feet over the larger portion of the area dredged. The upper section is about 2,400 feet long and 100 feet wide. About 2,200 linear feet of this section has been dredged to a depth of 16 feet, leaving only 200 linear feet to be dredged in addition to re-dredging where shoaling has occurred.

Operations during the fiscal year.—By hired labor work was in progress at the beginning of the fiscal year.

The work consisted of dredging with United States dredge No. 1, and the removal of hardpan by drilling and blasting with the Government drilling plant.

Dredging was continued until November 23; suspended during the winter; resumed March 31, and closed for lack of funds May 31, 1894. Seventy-nine thousand three hundred and thirty cubic yards of material were removed during the fiscal year, making the aggregate since the beginning of improvement 382,820 cubic yards.

Drilling and blasting hard pan was completed July 17, 1893. The area drilled from July 1 to 17 was 4,400 square feet. This quantity added to 38,550 square feet previously drilled makes the total area drilled and blasted since the commencement of the work 42,950 square feet.

Necessary repairs were made to the dredge, dump scows, and tug during the winter of 1893–'94.

Remarks and recommendations.—The formation of a channel having a uniform width of 200 feet was originally contemplated, but for reasons fully set forth in the Chief of Engineer's Report for 1891, pp. 2529–2530, it was deemed advisable to reduce the upper 2,600 linear feet to a width of 100 feet.

A comparison of the surveys made in 1889 and 1894 indicates that over the area thus far dredged considerable shoaling has occurred in places. Some 4,000 linear feet of the channel banks are not yet protected by docks, and it is believed that a large percentage of deposit comes from this source.

For the maintenance of the channel an appropriation of $10,000 is recommended.

Original estimate (see House Ex. Doc. No. 34, Fifty-first Congress, first session)	$109,609.80
Revised estimate (see Report of Chief of Engineers 1891, pp. 2529–2530)	74,500.00

APPROPRIATIONS.

Act of—	
September 19, 1890	$54,000.00
July 13, 1892	20,500.00
Miscellaneous receipts credited to appropriations	80.03
Total	74,580.03

Money statement.

July 1, 1893, balance unexpended	$12,958.63
Miscellaneous receipts credited to appropriation	26.53
	12,985.16
June 30, 1894, amount expended during fiscal year	12,710.89
July 1, 1894, balance unexpended	274.27
Amount (estimated) required for completion of existing project	10,000.00
Amount that can be profitably expended in fiscal year ending June,30,1896	10,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

The commercial statistics for the Menominee River are the same as for Menominee Harbor, Michigan, and Marinette, Wis.

J J 5.

IMPROVEMENT OF OCONTO HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Green Bay up the Oconto River to the city of Oconto.

Project.—The original project, adopted in 1882, provided for the formation of a channel 100 feet wide and 8 feet deep by extending the slab pier built by the city to the 10-foot contour in Green Bay, and dredging between the piers and up the river to Section Street bridge, a distance of about 2 miles, the piers to be parallel to each other and 150 feet apart.

Present work.—(1) North pier, 1,603 feet long, 20 feet wide. For 1,100 feet the piles are 5 feet apart; for the remaining 503 feet the piles are 4 feet apart on the channel side, and 2 feet apart on the outer side, the latter being provided with wale timbers, cross-ties, and tie-rods. The filling is composed of slabs and edgings ballasted with sand. (2) South pier, 2,151 feet long, 20 feet wide. For 1,850 feet the piles are 5 feet apart; the remaining 351 feet is close piling. The filling is composed of slabs and edgings ballasted with sand, except the outer 301 feet, which is covered with 2 feet thickness of stone. (3) The outer side of the south pier, beginning 300 feet from the outer end for a distance of 1,000 feet, is protected from ice pressure by a line of close piling, thence shoreward for a distance of 850 feet by riprap. (4) Additional stability is given to 1,850 feet of the south pier by a line of piles on the channel side 3 feet apart, provided with wale timbers, cross-ties, and iron tie-rods at intervals of 9 feet.

Depth of water.—Originally 2 feet, increased to 3½ feet by local enterprise.

Soundings taken April 24 and 25, 1894, showed governing depths as follows: At the entrance, a narrow channel close to the south pier, about 7 feet; thence up the river to Spies' mill, a distance of 9,000 feet, 6½ feet; thence to Section Street bridge, 4,000 feet, from 3½ to 4 feet.

The dredging done in June, 1894, increased the navigable depth at the entrance to 10 feet.

Operations during the fiscal year.—United States Dredge No. 1 was transferred from Menominee June 3, 1894, and dredging was begun on the 6th. During the remainder of the month 17,045 cubic yards of material were removed from between the piers.

Remarks and recommendations.—In order to maintain a depth of 8 feet of water periodical dredging will be necessary. The piers, being of a frail character, will require frequent repairs.

At the request of the local authorities and citizens interested, harbor lines for the north side of the river were agreed upon, and, under date of June 23, 1893, approved by the Secretary of War.

A survey made in August, 1893, for the purpose of establishing permanent marks to define the harbor lines approved June 23, 1893, indicated that lines slightly divergent would approximate more nearly to the natural river bank and be in every way better. The desired change was made and approved by the Secretary of War October 2, 1893, and permanent marks established for their identification.

It is understood that the parties most interested in this improvement are desirous of a modification of the project now in force, the object being to abandon further improvement of the long stretch of river and in lieu thereof secure an outer harbor or a greater depth of water at the entrance, but the scheme has not yet assumed definite form.

For maintenance and preservation it is estimated that $10,000 will be needed for the fiscal year ending June 30, 1896.

Estimated cost (see Report of Chief of Engineers, 1883, p. 1646)	$150,000

APPROPRIATIONS.

Act of—	
March 3, 1891	$10,000
August 2, 1882	15,000
July 5, 1884	15,000
August 5, 1886	8,000
August 11, 1888	20,000
July 13, 1892	3,000
Total	71,000

Money statement.

July 1, 1893, balance unexpended	$3,089.33
June 30, 1894, amount expended during fiscal year	1,534.85
July 1, 1894, balance unexpended	1,554.48
July 1, 1894, outstanding liabilities	16.18
July 1, 1894, balance available	1,538.30
Amount (estimated) required for completion of existing project	79,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	10,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. W. H. Young, mayor.]

Name of harbor, Oconto, Wis.; collection district, Milwaukee, Wis.; nearest lighthouse, Sherwood Point, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	212	12,800	210	12,540
Sail	82	4,750	82	4,750
Total	294	17,550	292	17,290

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Apples	15	Apples	22½
Beer	1,575	Bark (tan)	880
Fish	400	Brick	1.400
Iron and steel	100	Coal and coke	500,000
Lath	550	Iron and steel	25
Lumber	7,500	Lime and cement	240
Merchandise, general	300	Merchandise, general	3,000
Oats	1½	Oil	90
Oil	45	Plaster land	40
Saw logs	3,000	Pork and beef	120
Shingles	450	Potatoes	14
Ties, railroad	375	Provisions	15,000
Wood	2,000	Saw logs	18,000
		Stone	2,100
Total	16,311½	Wood	500
Total approximate value	$486,000	Total	541,431½
		Total approximate value	$506,100

BY ALL WAYS OF TRANSPORTATION.

EXPORTS	*Tons.*	IMPORTS.	*Tons.*
Agricultural implements	240	Agricultural implements	228
Apples	75	Apples	60
Bark, tan	2,750	Bark, tan	2,750
Barley	470	Barley	45
Beans	24	Beer	210
Beer	3,832½	Brick	1,642
Brick	306	Cattle	360
Butter	9	Chairs	40
Cattle	67½	Cheese	10
Coal and coke	10,000	Coal and coke	700,000
Fish	1,000	Corn	112
Flour	376	Eggs	4½
Hay	1,500	Fish	100
Hides	50	Flour	860
Hogs	100	Furniture	2,250
Iron and steel	100	Hay	80
Lath	412½	Hogs	40
Lime and cement	144	Iron and steel	52
Lumber	105,000	Leather	1
Merchandise, general	1,200	Lime and cement	480
Mill stuffs	500	Lumber	4,000
Oats	336	Malt	10
Oil	135	Marble	18
Pease	6	Merchandise, general	6,000
Plaster, land	100	Mill stuffs	4,000
Pork and beef	216	Oats	384
Poles, telegraph	4,080	Oil	180
Posts, fence	13,300	Pease	60
Potatoes	78	Plaster, land	100
Provisions	3,000	Pork and beef	240
Rye	11	Potatoes	27
Salt	180	Provisions	3,000
Saw logs	3,000	Rye	90
Shingles	3,000	Salt	180
Ties, railroad	5,600	Sash, doors and blinds	150
Wheat	360	Saw logs	18,000
Wood	7,600	Shingles	120
Wool	2	Stone	2,100
		Wheat	180
Total	169,160½	Wood	625
Total approximate value	$2,024,500	Total	748,788½
		Total approximate value	$1,760,400

J J 6.

IMPROVEMENT OF PENSAUKEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Green Bay into the Pensaukee River.

Project.—The original project, adopted in 1883, provides for continuing a slab pier, which had been built by private enterprise, until it should reach the 10-foot contour in Green Bay, and dredging a channel south of it to a depth of 10 feet and width of 100 feet, connecting the deep water in the river with the deep water in the bay.

Present works.—(1) A slab pier, 1,300 feet long and 20 feet wide, filled with slabs and edgings and ballasted with sand and stone. It was built in 1883, and repaired in 1885 and 1891. (2). One thousand six hundred feet of slab pier, built by private enterprise, was nearly all destroyed by a storm in 1885. The destruction of this work left the portion of the pier built by the United States a detached work.

Depth of water.—Originally 2 feet; increased by private enterprise to from 7 to 9 feet for a width of 30 feet. The destruction of the portion of the pier built by private enterprise by the storm of October, 1885, resulted in restoring the channel to about its original condition.

A survey made in May, 1890, showed the governing depth to be 2.8 feet.

Operations during the fiscal year.—There were no operations during the fiscal year ending June 30, 1894.

Remarks and recommendations.—For the preservation of the existing works it is estimated that $1,000 will be needed for the fiscal year ending June 30, 1896.

Should further improvement of this harbor be deemed necessary, it is believed that the modified project submitted in report dated February 2, 1892, the estimated cost of which is $8,800, would be all that is needed.

No arrivals and departures of vessels were reported at this harbor for the calendar year ending December 31, 1893. Several boats are engaged in fishing, and it is claimed that this business would materially increase if the water at the harbor entrance was deepened.

Estimated cost (see Report of Chief of Engineers, 1883, p. 1652)	$50,000

APPROPRIATIONS.

Act of—	
August 2, 1882	$10,000
July 5, 1884	5,000
Total	15,000

Money statement.

July 1, 1893, balance unexpended	$1,064.36
June 30, 1894, amount expended during fiscal year	71.00
July 1, 1894, balance unexpended	993.36

Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

J J 7.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

Object.—To secure a more direct and deeper channel from Green Bay into the mouth of the Fox River, where the harbor of Green Bay is located.

Project.—The original project, adopted in 1866, provided for dredging a channel 200 feet wide and 12 feet deep from the mouth of the Fox River, through Grassy Island, to the 12-foot contour in Green Bay, a distance of about 8,800 feet, and revetting some 650 feet of the same at Grassy Island. This project was completed in 1871.

A supplementary project, adopted in 1872, provided for straightening the channel and increasing its depth to 13 feet.

In 1874 it was decided to increase the depth to 14 feet. This increased the length to about 11,600 feet.

A modification of the existing project was approved August 5, 1892, to increase the depth of the present channel to 16 feet and extend it in a direct line through the bar that projects from Sable Point, making its total length about 16,500 feet.

Present works.—Revetments at Grassy Island: (1) West revetment, 620 feet long and 14 feet wide, with close piling on the channel side and anchor piles about 5 feet apart on the outer side. The timber superstructure is 5 feet high. This revetment was built in 1870, rebuilt above the water line in 1887, and is in good condition. (2) East revetment, 705 feet long and 14 to 17 feet wide, with close piling on the channel side and on the bay side close piling for 425 feet, and for the remaining 280 feet piles about 5 feet apart. The timber superstructure is 7 feet high. This revetment was built in 1869, rebuilt above the water line in 1885, and is in good condition.

Depth of water.—Originally a narrow and circuitous channel 6 feet in depth. The present channel is 200 feet wide and 14 feet deep.

Operations during the fiscal year.—Under contract dated October 1, 1892, with Mr. Christopher H. Starke, of Milwaukee, Wis., for dredging 120,000 cubic yards of material, more or less, work was in progress at the beginning of the fiscal year, and continued without interruption until September 23, 1893, resulting in the removal of 84,794.4 cubic yards of material during the fiscal year, and a total of 134,991.6 cubic yards under this contract. The channel formed was 100 feet wide, 10,200 feet long, and 16 feet deep.

By hired labor and purchase of materials in open market 70.3 cords of stone were obtained and applied as riprap and refilling the east revetment at Grassy Island at places where undue settlement had occurred.

With a view of establishing suitable dock lines a survey of Fox River was made, extending from Porlier street, in the city of Green Bay, to the mouth of the river. A map of the survey is completed. A tracing of a reduced copy of this map, with the addition of the projected channel to deep water in Green Bay, the latter taken from chart of United States Lake Survey, 1864, is submitted herewith.

In accordance with the proviso in act of July 13, 1892, appropriating $25,000 for improving harbor at Green Bay, Wis., "that $5,000 of said sum may, in the discretion of the Secretary of War, be expended on the Fox River, below De Pere, Wis.," by hired labor and the use of a dredge belonging to the Fox River improvement, work was in progress at the beginning of the fiscal year, and, as stated in last annual report, nearly completed.

In July, 1893, 130 cubic yards of material were removed from t channel, completing the object sought, viz: a clear waterway with least width of 150 feet and depth of 12 feet; the total number of cub yards of material removed since the beginning of the work, August 2 1892, being 41,705.

Remarks and recommendations.—The construction of docks encroac ing upon the channel of Fox River by owners of the river front in t cities of Green Bay and Fort Howard indicated the necessity of esta lishing suitable dock lines at an early day, to render void any und projection of docks already built and to avoid future encroachmen that were likely to occur, led to a survey, made under my direction b Mr. L. M. Mann, C. E., in October and November, 1893. This surve connects with one made by Mr. Mann in 1889 of Fox River from De Per to Green Bay.

The map is completed, and covers a distance of about 6 miles. I shows the docks in the cities of Green Bay and Fort Howard; mouth of Fox River; the present 14-foot channel, and the 16-foot channel i process of construction through Sable Point Bar.

The present available depth of water is 14 feet, and, owing to th peculiar physical characteristics of this harbor, the navigable dept can not be increased nor any additional benefit to navigation obtaine until the proposed channel, 16,500 feet long, is dredged its entire lengt and made of navigable width. The 16-foot channel is now 10,200 fee long.

The extension, therefore, so urgently needed is 6,300 feet.

To accomplish this much-needed improvement an appropriation o $71,915 is recommended for the fiscal year ending June 30, 1896.

Estimated cost of the project adopted in 1881 (see Report of Chief of Engineers, 1881, p. 2069)	$135,000
Estimated cost for a channel 16 feet deep submitted February 12, 1892	91,915

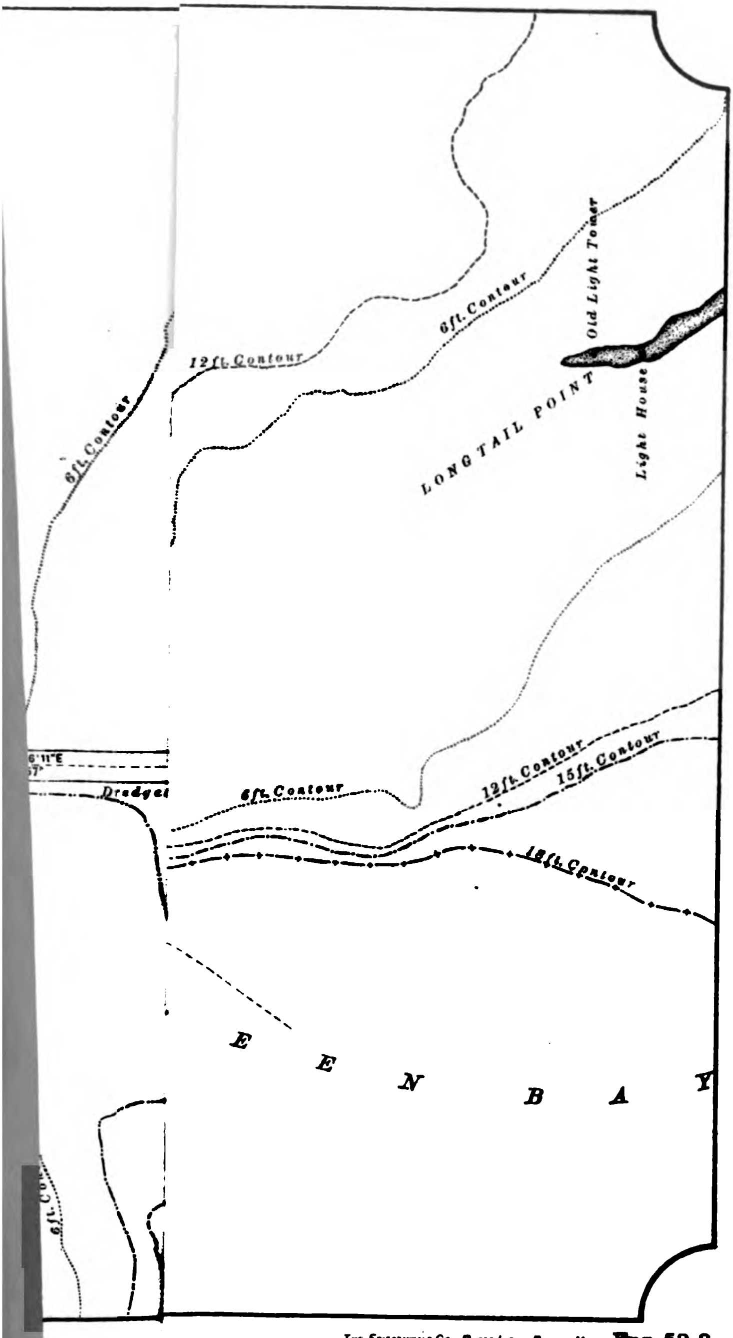
APPROPRIATIONS.

Act of—		Act of—	
June 23, 1866	$30,500.00	March 3, 1881	$5,000.00
March 2, 1867	45,000.00	August 2, 1882	20,000.00
July 25, 1868 (allotted)	17,500.00	July 5, 1884	10,000.00
April 10, 1869 (allotted)	44,550.00	August 5, 1886	7,000.00
July 11, 1870	17,500.00	August 11, 1888	10,000.00
March 3, 1871	17,500.00	September 19, 1890	10,000.00
March 3, 1873	20,000.00	July 13, 1892	25,000.00
June 23, 1874	10,000.00	Miscellaneous receipts credited to appropriations	52.50
March 23, 1875	10,000.00		
August 14, 1876	8,000.00	Total	322,602.50
June 18, 1878	5,000.00		
March 3, 1879	4,000.00		
June 14, 1880	6,000.00		

Money statement.

July 1, 1893, balance unexpended	$21,532.53
June 30, 1894, amount expended during fiscal year	20,449.07
July 1, 1894, balance unexpended	1,083.46
Amount (estimated) required for completion of existing project	71,915.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	71,915.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.



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COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. Daniel Bradley, deputy collector of customs, Green Bay, Wis.]

Name of harbor, Green Bay, Wis.; collection district, Milwaukee, Wis.; nearest light-house, Grassy Island, Wisconsin.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	381	166,991	401	167,848
Sail	243	44,701	241	46,106
Total	624	211,692	642	213,954

Principal articles of export and import for the calendar year ending December 31, 1892.

[Furnished by Mr. Charles Hartung, deputy collector of customs.]

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Barley	322	Apples	50
Barrels, oil, empty	150⅛	Barley	132¾
Bran	63	Bolts	2,352
Brick	2,878	Canned goods	34¼
Cattle	30	Candles	4
Clay	30	Coal and coke	113,500
Coal and coke	32	Fish	22⅛
Corn	3	Glassware	15
Eggs	2¾	Gravel	400
Fish	130	Horses	3½
Flour	29,945⅛	Iron and steel	466
Furniture	2	Lemons	31
Hay	104	Lime and cement	99⅛
Horses	18¼	Lumber	5,869⅛
Hogs	2	Merchandise, general	2,316⅛
Iron and steel	50	Nails	526¼
Lath	165	Oil	53
Lumber	21	Machinery, mill	300
Malt	1¾	Pipe, sewer	90
Merchandise, general	7,570	Posts, fence	25¼
Oats	6,481½	Potatoes	12
Oil	8¾	Rags	29⅛
Paper	100	Sand	1,600
Pickles	12	Salt	3,714¼
Rags	100	Sheep	13¼
Rye	1,220¾	Shingles	163
Salt	284½	Soap	28¼
Shingles	150	Stone	1,115
Vinegar	7¼	Sugar	1,410
Wagons and carriages	55	Ties, railroad	42
Wheat	3, 56½	Wheat	81½
		Wood	5,937⅛
Total	53,407	Wood pulp	26,142
		Wire	21
		Total	166,601

NOTE.—Efforts were made, but unsuccessfully, to obtain an accurate record of exports and imports for 1893; therefore those for 1892 are repeated. Mr. M. J. McCormick, secretary of Business Men's Association, states:

"* * * I think 20 per cent anyway, or possibly 25 per cent, might be added to 1892 for 1893, as we handled 25 per cent more flour from this port during 1893 than we did in 1892, and we handled at least 5,000 tons of paper stock from the East for the Fox River paper mills during 1893. We had none of this in 1892. * * *"

J J 8.

STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

The provisions of act of July 13, 1892, concerning making free to commerce the Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin, having been complied with, under orders of the Chief of Engineers, U. S. Army, dated April 24, 1893, the canal was formally transferred by the canal company and accepted by the United States April 25, 1893, and deed recorded in Door County, Wis., May 2, 1893. Jurisdiction was ceded by the State of Wisconsin by act approved March 6, 1893.

The complete and exhaustive history and description of this work, published in Senate Ex. Doc. No. 34, Forty-seventh Congress, second session, and House Ex. Doc. No. 106, Forty-ninth Congress, second session; also in Chief of Engineers' Reports, 1883, pp. 1657–1678, and 1887, pp. 2017–2037, renders unnecessary more than a brief description at the present time, as the conditions have not materially changed since then.

The object of the improvement was the formation of a more direct waterway from Menominee, Peshtigo, and other ports in the southern part of Green Bay, to Chicago, Milwaukee, and other ports in the southerly part of Lake Michigan.

The project as carried out by the canal company resulted in an open cut without locks or gates, about 13 feet deep, 100 feet wide at top, about 65 feet wide at bottom, and 7,200 feet long; also dredging, in continuation of the canal proper, a channel of the same depth in Sturgeon Bay for a distance of 6,100 linear feet.

The Lake Michigan entrance is protected by piers built by the United States, at a cost (including dredging) of $171,421.60.

Present works.—Canal: Of the 14,400 linear feet of canal banks, 8,437 linear feet are provided with sheet-pile revetments, composed of planks 4 inches thick, with battens 2 inches thick. The planks are 18 feet long and project about 3 feet above the established datum plane (viz, 3.06 feet below high water of 1838). The remaining 5,963 feet is unprovided with any protection.

At right angles to the canal, revetments, originally of similar construction, extend on each side to the harbor piers a distance of about 350 feet.

Some 600 linear feet of these revetments were modified in form during the past year by cutting off the sheet piling at the water surface and depositing a heavy riprap of stone in front, so as to form a sloping shore, instead of a vertical wall, to receive the force of heavy lake waves that find entrance between the harbor pier heads.

In continuation of the canal proper, an open dredged cut was made in Sturgeon Bay for a distance of 6,100 linear feet.

The revetments are not of modern first-class construction, and quite extensive repairs were imperative in order to maintain a reasonable degree of efficiency.

Depth of water.—Soundings taken in April, 1893, showed a depth of from 13 to 14 feet for a width of about 65 feet between the revetments; for a distance of about 1,400 feet beyond the revetments the navigable width did not exceed 30 feet. During the fiscal year, with funds provided for operating and care, the section beyond the revetments was increased to a width of 60 feet, and a third cut with the dredge is well under way, which when completed will give it a width of 90 feet.

Operations during the fiscal year.—There being no funds available for its enlargement or improvement, there were no operations during the fiscal year other than restoration and maintenance of channel and repairs to revetments, which are fully described in the report for "operating and care," to which reference is invited.

Remarks and recommendations.—The law, section 7, river and harbor act, July 5, 1884, relating to other United States canals, it is considered should be made applicable to this canal also.

Navigation through the canal closed for the season December 11, 1893, and was resumed March 10, 1894.

The canal and harbor are practically one work; if the canal is defective or out of order the harbor suffers in consequence, as is shown by the following:

A survey made in 1881 showed a depth of water on line of the present harbor pier heads of 18 feet. The piers were completed in 1884; soundings taken in 1894 show an average depth between the pier heads of 14.7 feet, and that the 18-foot contour has advanced about 300 feet, being now where 20.5 feet existed in 1881.

Since 1881 the shore line at its intersection with the north pier has not changed, and the south shore line has advanced but 35 feet.

It is evident therefore that the deposit that has caused the shoaling is not derived from shore drift, but that the canal is its source, and chiefly that portion of it not provided with revetments, where an examination of the banks indicate that rapid and extensive erosion has occurred and is still in progress.

To avoid unnecessary periodical dredging in the harbor or the expensive expedient of extension of the piers, which at best would only alleviate, not cure, the difficulty, the canal should be revetted its entire length as soon as possible.

The benefit that this work now affords to the general commerce of the lakes and the extent that it is sought as a harbor of refuge is well illustrated by a report from Supt. Dier, stating that during a severe storm that prevailed November 10 and 11, 1893, no less than 57 craft, steam and sail, were sheltered in Sturgeon Bay at one time.

The estimate for year ending June 30, 1896, for completing the revetments from their present termination to the 14 foot contour in Sturgeon Bay and placing them so as to widen the canal at water surface for this portion of its length to 160 feet is as follows:

ESTIMATE.

Dredging 150,000 cubic yards, at 15 cents	$22,500
6,000 linear feet of revetment, at $10	60,000
2,000 linear feet of spring fender piling, at $3.50	7,000
	89,500
Add 10 per cent for superintendence and contingencies	8,950
Total	98,450

APPROPRIATION.

Act of July 13, 1892	$81,833

Money statement.

Amount (estimated) required for completion of existing project	$98,450.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	98,450.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Adam N. Dier, superintendent Sturgeon Bay and Lake Michigan Ship Canal.]

Name, Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin; collection district, Milwaukee, Wis.; nearest light-house, on north pier head, entrance to harbor.

Arrivals and departures of vessels.

Description.	Bound down.		Bound up.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1,041	323,939	912	269,987
Sail	1,107	249,146	858	153,693
Unrigged (scows)	112	20,028	120	20,945
Total	2,260	593,113	1,890	444,625

Principal articles of export and import.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS BOUND UP.	*Tons.*	IMPORTS BOUND DOWN.	*Tons.*
Apples	11	Apples	860
Bark, tan	453½	Brick	770
Coal and coke	2,400	Coal and coke	5,094
Dairy products	756	Corn	620
Fish	25	Fish	723
Flour	1,183¾	Flour	411
Grindstone	410	Hay	2,048
Hides	464	Iron and steel, manufactured	6,748¾
Iron, pig	235	Lime and cement	270
Lumber	534,868	Lumber, hard-wood	220
Merchandise, general	396	Merchandise, general	32,728
Oil	6¾	Mill stuffs	146
Pease	160	Oil	357½
Posts, fence	382	Pork and beef	83¾
Potatoes	351	Potatoes	185
Saw logs	1,200	Salt	5,721½
Stone	97,774	Wagons and carriages	7
Ties, railroad	2,461	Wood pulp	885
Trees	416	Total	57,878½
Wheat	2,786¾	Total approximate value	$5,530,368.50
Wood	19,936		
Total	666,675¾		
Total approximate value	$5,882,427.60		

J J 9.

OPERATING AND CARE OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

There being no funds available for the enlargement or general improvement of the canal, operations have necessarily been confined to work incident to operating and care, examinations, maintenance of lights, keeping a record of vessels and tonnage through the canal, and such dredging and repairs as were necessary for maintenance.

By the use of United States dredge No. 2 several shoal places between the revetments were removed, and beyond the revetments where the required depth of channel had an available width of but 30 feet the width has been increased to 60 feet, and a third cut with the dredge is well under way, which when completed will give a clear width of 90 feet. Thirty-seven thousand seven hundred and forty-four cubic yards of material were excavated.

During the winter of 1893–'94 repairs were made to the dredging plant.

Broken or otherwise damaged wale, cap, and binder timbers, and iron tie-rods were removed at intervals from nearly the entire length of the revetted portion of the canal and replaced with new materials, or refastened if new materials were not required. Nine hundred and fifty-one linear feet of 12 by 12 inch pine timber for wales; 94 iron tie-rods, each 17 feet long, being used for this purpose, in addition to smaller timber for caps and binders, and a large number of screw bolts.

About 600 linear feet of the revetments on the harbor front were cut down to the water surface and provided with riprap in order to form a sloping shore and thereby decrease the wave disturbance in the harbor and at the canal entrance.

About 350 linear feet of revetment built in 1881 on the north side of the canal, adjacent to the harbor, was in such an advanced stage of decay as to demand rebuilding above the water line, and so defective in construction as to require an additional line of sheet piling. Its renovation is now in progress, but no portion of it is entirely completed. Repairs were made to the office building, row boat and outhouses.

A house, of dimensions 12 by 14 feet, to afford shelter and quarters for the night watchman and light-keeper was built. Also a warehouse 50 by 24 feet for the storage of engineer property not in use, belonging to all harbors in this district, was built and paid for from appropriations from various harbors, and property from Waukegan, Manitowoc, Ahnapee, and Green Bay transferred and stored therein.

The expenditures during the year ending June 30, 1894, amounted to $14,579.11, paid for from an allotment from the indefinite appropriation for "operating and care of canals, and other works of navigation," provided by section 4 of river and harbor act of July 5, 1884. In accordance with this section an itemized statement of the expenditures is appended hereto.

Money statement.

July 1, 1893, balance unexpended	$860.57
Amount allotted for fiscal year ending June 30, 1894	20,500.00
	21,360.57
June 30, 1894, amount expended during fiscal year	14,579.11
July 1, 1894, balance unexpended	6,781.46
July 1, 1894, outstanding liabilities	1,132.59
July 1, 1894, balance available	5,648.87
Amount (estimated) for expenditure in fiscal year ending June 30, 1895	*10,301.13
Amount available for fiscal year ending June 30, 1895	15,950.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1893.				
July 26	1	Swain & Tate Co	Rules, etc	$6.00
31	2	Maj. James F. Gregory	Mileage	2.00
Aug. 7	1	Hired men	Services, July, 1893	228.33
11	2	Scofield & Co	Iron bolts, etc	146.35
11	3	R. T. Thorp	Hire of team	2.00
11	4	H. L. Jackson	Blue prints	.75
11	5	Swain & Tate Co	Books	55.00
11	6	Adam N. Dier	Traveling expenses	4.00

* Amount allotted if estimate is approved.

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1893.				
Aug. 25	7	D. C. Thompson	Lumber	$128.52
28	8	Swain & Tate Co	Rules for navigation	1.50
31	9	Hired men	Services	373.33
Sept. 2	1	Patsy J. Hennessey	Iron, etc	27.13
2	2	A. W. Lawrence & Co	Oil, etc	7.20
2	3	Scofield & Co	Bolts, etc	36.71
13	4	L. M. Mann	Traveling expenses	11.30
13	5	Eugene Dietzgen Co	Eyepiece, etc	11.40
29	6	W. D. Halstead	Oil	30.18
29	7	F. B. Lowell	Coal	34.13
30	8	Tifft & Hay	Rope, etc	19.69
30	9	Hired men	Services	322.66
Oct. 3	1	do	Services September, 1893	234.83
3	2	E. A. Cannon	Traveling expenses	4.50
6	3	Ernest Carrington	Towing	25.00
6	4	F. Cosme	Building chimney	6.00
6	5	Scofield & Co	Paint, etc	12.60
10	6	Western Union Telegraph Co	Telegrams	3.03
14	7	John Corry	Coal	251.85
14	8	N. S. Washburn & Co	Lumber, etc	38.07
17	9	M. J. Schmitt & Co	Blue prints	.33
17	10	E. A. Cannon	Traveling expenses	9.00
31	11	A. Ross Houston	Services	200.00
Nov. 3	1	William Murrills	do	44.00
3	2	Hired men	Services October, 1893	605.00
3	3	do	do	238.58
3	4	E. Corydon Prescott	Driver casting, etc	63.49
3	5	George D. Nau	Towing	50.00
3	6	The Cincinnati Corrugating Co	Iron, etc	151.72
3	7	R. T. Thorp	Labor	31.50
3	8	Scofield & Co	Bolts, etc	15.79
3	9	A. W. Lawrence & Co	Oil, etc	8.23
3	10	E. A. Cannon	Traveling expenses	3.35
3	11	Tifft & Hay	Piles, etc	39.11
3	12	Leathem & Smith	Coal	6.69
3	13	Theodore Jacobs	Fence posts	3.60
4	14	Hired men	Services, October, 1893	56.00
20	15	John M. Borgman	Stone	765.20
20	16	E. A. Cannon	Traveling expenses	7.75
22	17	Goodrich Transportation Co	Freight charges	14.40
23	18	Leathem & Smith	Dockage	1.08
27	19	Hired men	Services	399.17
30	20	E. A. Cannon	do	150.00
30	21	N. S. Washburn & Co	Lumber	151.88
30	22	E. A. Cannon	Traveling expenses	7.87
30	23	Hired men	Services	215.33
Dec. 7	1	Reynolds Lumber Co	Lumber	4.32
7	2	Scofield & Co	Sash, etc	13.19
7	3	A. W. Lawrence & Co	Oil, etc	6.69
12	4	John Walker	Hire of tug	312.00
23	5	H. H. West Co	Book, etc	6.65
28	6	Tifft & Hay	Wood, etc	73.57
28	7	do	Shingles, etc	23.65
31	8	Hired men	Services	104.17
1894.				
Jan. 4	1	do	Services, December, 1893	98.50
4	2	Leathem & Smith	Coal	24.69
4	3	Hired men	Services, December, 1893	242.37
6	4	Nick Nelson	Building chimney	8.00
10	5	N. S. Washburn & Co	Pine flooring, etc	70.16
11	6	Tifft & Hay	Blinds, etc	8.41
31	7	The Evening Wisconsin Co	Office rent	71.00
31	8	Hired men	Services	173.83
Feb. 3	1	Tifft & Hay	Oakum, etc	51.50
3	2	Vulcan Iron Works	Dipper-handle racks	56.00
3	3	E. Corydon Prescott	Steel pinions, etc	145.33
5	4	M. J. Schmitt & Co	Blue prints, etc	13.87
14	5	Des Forges & Co	Stationery	30.80
16	6	E. A. Cannon	Telegrams	1.28
28	7	Hired men	Services	145.33
28	8	Bernhard Dieter	Wall paper, etc	4.00
28	9	R. T. Thorp	Labor	10.50
28	10	Scofield & Co	Paint, etc	2.33
28	11	M. J. Schmitt & Co	Blue prints	7.77
28	12	Wyckoff, Seamans & Benedict	Paper, etc	8.85
Mar. 12	1	E. A. Cannon	Traveling expenses	21.96
23	2	James McKay & Co	Chain	118.75
30	3	E. A. Cannon	Traveling expenses	16.59

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1894.				
Mar. 31	4	E. A. Cannon	Services	$150.00
31	5	Hired men	......do	169.38
31	6	......do	......do	198.51
31	7	......do	......do	189.30
Apr. 4	1	E. A. Cannon	Traveling expenses	17.22
4	2	Scofield & Co	Pump, etc	5.60
4	3	Bernhard Dieter	Wall paper, etc	4.00
4	4	Theodore Jacobs	Fence posts, etc	13.20
4	5	A. W. Lawrence & Co	Oil, etc	8.11
4	6	R. T. Thorp	Labor	3.50
7	7	J. S. Hay	Rope, etc	70.52
20	8	E. A. Cannon	Traveling expenses	5.50
28	9	W. D. Halstead	Oil, etc	27.30
30	10	Hired men	Services	630.00
30	11	......do	......do	226.83
30	12	E. A. Cannon	......do	150.00
30	13	John Corry	Coal, etc	124.41
30	14	Ferstrum & Fred	Plates, etc	44.03
30	15	Fellows & Bliss	Coal	33.25
30	16	E. G. Karker	Painting	10.00
30	17	Theodore Jacobs	Pedestal	11.00
30	18	Scofield & Co	Oars, etc	6.18
30	19	John M. Laurie	Corner stones	6.00
30	20	E. Gillen	Hire of tug	150.00
May 2	1	Reynolds Lumber Co	Coal, etc	48.50
2	2	Andrew Anderson	Team hire	8.00
2	3	William Murrills	Services	20.00
2	4	......do	Traveling expenses	13.81
2	5	Louis Bavry	Wood	415.69
2	6	E. Corydon Prescott	Grate bars, etc	198.19
3	7	Geo. L. Hastings	Iron, etc	16.93
7	8	J. S. Hay	Paint, etc	94.89
14	9	Western Union Telegraph Co	Telegrams	.66
14	10	E. A. Cannon	Traveling expenses	5.00
21	11	Continental Bolt and Iron Works	Bolts, etc	110.80
31	12	Hired men	Services	420.01
31	13	......do	......do	210.83
31	14	E. A. Cannon	Services	150.00
31	15	......do	Traveling expenses	4.55
31	16	E. Gillen	Transporting pile-driver	275.00
31	17	Leathem & Smith	Coal	144.38
31	18	W. D. Halstead	Oil, etc	11.88
31	19	J. S. Hay	Rope, etc	28.20
31	20	A. W. Lawrence & Co	Oil, etc	11.65
31	21	F. A. Hagen	Stone	175.35
31	22	Scofield & Co	Paint, etc	5.56
31	23	R. T. Thorp	Team hire	3.50
31	24	W. M. Jackson	Launching scows	40.00
31	25	Hired men	Services	352.06
31	26	William Murrills	Traveling expenses	10.89
June 7	1	E. Gillen	Hire of tug	150.00
8	2	Leathem & Smith	Dockage	2.25
12	3	Western Union Telegraph Co	Telegrams	2.51
16	4	M. J. Schmitt & Co	Blue prints	3.18
21	5	Continental Bolt and Iron Works	Iron rods, etc	64.35
26	6	Herman Voss	Tag boards, etc	.74
26	7	E. G. Karker	Wall paper, etc	10.00
26	8	Scofield & Co	Drive well, etc	20.42
26	9	John M. Laurie	Stone	729.38
27	10	Hoffman & Billings Mfg. Co	Hose	47.20
27	11	N. S. Washburn & Co	Flooring	4.20
30	12	Hired men	Services	294.01
30	13	......do	......do	215.33
30	14	Leathem & Smith	Coal	54.00
30	15	Hired men	Services	482.27
30	16	J. S. Hay	Oil, etc	41.23
30	17	......do	Tool steel, etc	85.90
30	18	Leathem & Smith	Coal	42.00
30	19	......do	Dockage	88
30	20	E. Gillen	Hire of tug	150.00
		Total		14,579.11

J J 10.

IMPROVEMENT OF HARBOR OF REFUGE AT ENTRANCE OF STURGEON BAY AND LAKE MICHIGAN SHIP CANAL, WISCONSIN.

Object.—To form a harbor of refuge inclosing the Lake Michigan entrance to the Sturgeon Bay and Lake Michigan Ship Canal and also to afford a safe entrance to the canal in rough weather.

Project.—The original project was submitted in 1871 and adopted in 1873. It provided for the construction of converging piers inclosing a triangular area of about 10 acres, which was to be dredged out to the requirements of navigation at that time. The piers were to be about 1,200 feet long, 850 feet apart at the shore line, and 250 feet at the outer end.

Supplementary projects adopted in 1879 and 1880 provided for sheet-piling the pile piers, extending each pier 150 feet by detached works, so as to increase the width of entrance from 235 feet to 335 feet, and dredging to obtain at least 16 feet in depth over so much of the area of the basin as would be useful to vessels entering the harbor.

Present works.	Width.	North pier, length.	South pier, length.
Slab pier:	*Feet.*	*Feet.*	*Feet.*
Piles 4 feet apart	14	100	100
Close piling	14	150	150
Pile piers, close piling	14	512	512
Do	18	32	32
Crib pier	20	200	200
Do	24	200	200
Length of each main pier	....	1, 194	1, 194
Crib piers	24	100	100
Do	30	50	50
Length of each detached pier	....	150	150
Total length of each pier	....	1, 344	1, 344

Guide piling to connect main and detached piers	feet..	333
North slab and pile pier sheet-piled	do...	692
South slab and pile pier sheet-piled	do...	700
Material dredged	cubic yards..	178, 382

The slab and pile piers were built in 1873-'74; the pile piers are in fair condition; the slab piers were rebuilt above the water line in 1889-'90. The crib piers were built in 1878-1884, and are in fair condition. The guide piling which connects the main and detached piers, built in 1881, is considerably decayed, and will need to be reconstructed at an early date.

Depth of water.—Soundings taken in April, 1894, showed a navigable depth of about 13 feet. This has been increased to 16 feet by dredging in May and June.

Operations during the fiscal year.—By hired labor and purchase of materials in open market repairs were made to the north and south piers and the guide piling that connects the north, main, and detached piers. The piers were injured to some extent by heavy gales and by ice, but the chief cause of damage was by vessels colliding with them during foggy weather, or the inopportune breaking of towlines when heavy seas were running.

Repairs were also made to the dredging plant and inspectors' house, a small structure built in 1880, which serves as office and quarters for inspectors and overseers whenever work is in progress.

United States dredge No. 2 removed 14,260 cubic yards of material, resulting in increasing the navigable depth from Lake Michigan to the canal from 13 feet to 16 feet.

Remarks and recommendations.—A comparison of soundings taken in April, 1894, with previous surveys indicates an advancement, on lines in prolongation of the piers, of the 18-foot contour since 1884 of about 300 feet, and during the past year a deposit in the channel proper, leading from the lake to the canal entrance, of over 10,000 cubic yards; over the entire area inclosed by the piers the amount of material deposited is much greater.

Annual dredging under existing conditions will be necessary.

The canal being the source of the materials causing this shoaling, the subject is discussed more fully in the report on the canal, to which attention is invited.

In his report on the canal for the current year the superintendent states as follows as to the beneficial effect on the harbor by modifications made during the past year in the revetments built by the canal company in 1881 to protect the harbor front:

> * * * A gradual slope of the shore along these sections of the work was obtained by riprapping with stone to the water surface and protecting the adjacent shore by depositing stone from the harbor front back for a distance of about 16 feet.
>
> The results which were expected to follow the cutting away of the sheet piling on the harbor front, thus removing a directly vertical front and giving the sea a natural slope to spend its force on, have been fully realized.
>
> The disturbance at the harbor entrance and in the channel used by craft in entering the canal from the lake which was primarily caused by heavy reflected waves has been reduced to a minimum, and reflected waves are now scarcely perceptible, even during the most severe storms. * * *

The transfer of the canal to the United States adds largely to the importance of the harbor, and should it be decided to enlarge and deepen the canal, a new project to provide a deeper channel and better facilities for entering will then be necessary.

For the maintenance of the channel and piers an appropriation of $7,000 is recommended for the fiscal year ending June 30, 1896.

Estimated cost (see Report of Chief of Engineers, 1874, part 1, p. 141)...	$180,000

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1873	$40,000.00	August 5, 1886	$5,000.00
June 23, 1874	10,000.00	September 19, 1890	3,000.00
June 18, 1878	30,000.00	July 13, 1892	5,000.00
March 3, 1879	30,000.00	Miscellaneous receipts credited to appropriations	182.50
June 14, 1880	10,000.00		
March 3, 1881	10,000.00		
August 2, 1882	20,000.00		
July 5, 1884	10,000.00	Total	173,182.50

Money statement.

July 1, 1893, balance unexpended	$3,564.54
June 30, 1894, amount expended during fiscal year	1,803.64
July 1, 1894, balance unexpended	1,760.90
Amount (estimated) required for completion of existing project	7,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	7,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

See the statistics with report on Sturgeon Bay and Lake Michigan Ship Canal, Wisconsin.

J J 11.

IMPROVEMENT OF AHNAPEE HARBOR, WISCONSIN.

Object.—To secure a small artificial harbor for local purposes in the Ahnapee River with a navigable channel leading thereto from Lake Michigan.

Project.—The project of improvement adopted in 1875 provided for the formation of a small artificial harbor connected with the lake by a channel 100 feet wide and 12 feet deep, to be formed by the construction of two piers extending from the shore line to the 18-foot contour in the lake; also for blasting and dredging rock from the river bed near its mouth for a distance of 750 feet.

In accordance with a modification of the original project, approved September 27, 1884, the cribs sunk in extension of the piers have been placed 50 feet farther from the center line of the channel between the piers than the old piers, and will afford when completed a 200-foot entrance between the pier heads.

Present works.—(1) North pier, 1,102 feet in length, composed of 352 feet of pile pier, 320 feet of which is 14 feet wide, and 32 feet 20 feet wide; also 750 feet of cribs 20 feet wide. (2) South pier, 1,125 feet in length, composed of 625 feet of pile pier 14 feet wide, and 500 feet of cribs 20 feet wide. The pile piers were built 1871–1874. The south pier was provided with sheet piling in 1880, and the north pier in 1891. The main and detached piers are connected by 225.6 linear feet of guide or fender piling, built in 1893. The pile-pier superstructure is considerably decayed and requires renewal; in other respects both piers are in good condition. The crib piers were built in 1875–1889 and are in good condition.

Depth of water.—Original, 12 feet. Soundings made in April, 1894, showed a depth of water at the entrance of from 15 to 16 feet and at the shore end of the harbor piers about 10½ feet.

Operations during the fiscal year.—Under contract dated December 15, 1892, with Mr. John M. Borgman, of Kewaunee, Wis., for the construction of 200 linear feet, more or less, of guide piling to connect the main and detached piers, work was begun August 15, 1893, and completed October 20, 1893, resulting in the construction of 112.7 feet on the north side and 112.9 feet on the south side, a total of 225.6 linear feet.

By hired labor and purchase of materials in open market minor repairs were made to the north detached pier head.

Remarks and recommendations.—To complete the project the following work is required: One hundred linear feet of cribs for extending each pier 50 feet; the removal of about 3,500 cubic yards of rock by drilling, blasting, and dredging.

The docks built by the city and private parties are poorly constructed, especially those on the north side allow large quantities of material to pass through them into the channel, adding largely to the dredging required to maintain a channel of the depth needed.

Should an appropriation be made for the fiscal year ending June 30, 1896, it is contemplated expending it for pier extension, rock removal, dredging, and renewal of superstructure to the pile piers. An appropriation of $20,000 is recommended, $8,000 of which is needed for rebuilding pile-pier superstructure.

The Ahnapee and Western Railroad, a new line connecting Ahnapee with the Kewaunee, Green Bay and Western Railroad at a point about midway between Kewaunee and Green Bay, was completed in September, 1892. It is expected that this will increase the importance of this harbor.

Estimated cost (see Report of Chief of Engineers, 1876, part 2, pp. 346–359; 1880, p. 1910)	$175,000
Additional estimate (see Report of Chief of Engineers, 1891, p. 2539)	10,000
Total	185,000

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	July 5, 1884	$15,000
June 10, 1872	25,000	August 5, 1886	15,000
March 3, 1875	25,000	August 11, 1888	5,000
August 14, 1876	8,000	September 19, 1890	6,000
June 18, 1878	8,000	July 13, 1892	7,000
March 3, 1879	7,000	Miscellaneous receipts credited to appropriations	220
June 14, 1880	7,000		
March 3, 1881	8,000		
August 2, 1882	12,000	Total	173,220

Money statement.

July 1, 1893, balance unexpended	$6,311.90
June 30, 1894, amount expended during fiscal year	4,077.73
July 1, 1894, balance unexpended	2,234.17
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

List of materials used and cost of same in place for building 225.6 linear feet of guide piling to connect the main and detached piers at Ahnapee Harbor, Wisconsin, under contract dated December 15, 1892, with Mr. John M. Borgman, of Kewaunee, Wis.

Articles.	Quantities.	Price per unit.	Amount.
Round piles ......linear feet	5,390	$0.25	$1,347.50
Oak timber ......feet, B. M.	5,808	55.00	319.44
Pine timber ......do	8,964	35.00	313.74
Iron tie-rods and screw bolts ......pounds	12,518	.05	625.90
Iron T railroad rails ......do	9,012	.03½	315.42
Iron spikes ......do	264	.05	13.20
Total			2,935.20

Average cost per running foot, $13.01.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by M. T. Parker, mayor.]

Name of harbor, Ahnapee, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pier head, Ahnapee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	351	192,391	349	192,330
Sail	298	24,377	297	24,371
Total	649	216,768	646	216,701

Principal articles of export and import.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Agricultural implements	30	Agricultural implements	640
Apples	37	Apples	52
Bark, tan	594	Beans	6
Barley	214	Beer and liquors	300
Beer and liquors	105	Brick	140
Butter	103	Cattle	40
Cattle	270	Chairs	7
Cheese	685	Coal and coke	340
Eggs	94	Corn	37
Fish	165	Flour	67
Flour	236	Furniture	17
Furniture	132	Horses	90
Hay	900	Iron and steel	240
Hides	35	Lath	137
Hogs	40	Leather	30
Horses	113	Lime and cement	59
Lumber	112	Lumber	3,210
Lintels	270	Machinery, heavy	94
Marble	24	Marble	25
Merchandise, general	40	Merchandise, general	3,800
Mill stuffs	100	Millstuffs	108
Oats	384	Oats	32
Pease	3,510	Oil	171
Pork and beef	34	Pease	9
Posts, fence	1,140	Plaster, land	45
Potatoes	390	Provisions	440
Provisions	20	Salt	285
Rags	22	Sash, doors, and blinds	28
Rye	252	Saw logs	195
Sheep	24	Sheep	3
Shingles	900	Wagons and carriages	67
Ties, railroad	4,200	Woodenware	6
Wheat	2,700		
Wood	2,500	Total	10,720
Woodenware	495		
Wool	1	Total approximate value	$797,425
Total	20,871		
Total approximate value	$866,900		

J J 12.

IMPROVEMENT OF KEWAUNEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Kewaunee River, where the harbor of Kewaunee is situated.

Project.—The project for the improvement of this harbor was adopted in 1881, and provides for the formation of a channel from a point about 2,000 feet south of the original mouth of Kewaunee River, through a spit of land about 300 feet wide, affording communication between the river and Lake Michigan. From the lake end of this cut two parallel piers, 200 feet apart, are to be constructed, each 1,650 feet long, extending to the 18-foot contour. Between the piers and through the cut the channel is to be dredged to a depth of 14 feet.

Present works.—Pile piers lined with sheet piling: (1) The north pier is 1,500 feet long—1,250 feet 16 feet wide and 250 feet 20 feet wide. (2) The south pier is 1,425 feet long—1,125 feet 16 feet wide and 300 feet 20 feet wide. They were built in 1881-'93 and are in good condition.

Depth of water.—Originally about 2 feet. Soundings completed April 12, 1894, showed the existence of a channel of navigable width centrally located between the piers 13.6 feet deep.

Operations during the fiscal year.—Under contract dated August 27, 1892, with Mr. John M. Borgman, of Kewaunee, Wis., for the construction of 550 linear feet of pile pier, work was in progress at the beginning of the fiscal year and continued until the completion of the contract, October 13, 1893.

During the fiscal year the north pier was extended 250 feet, and the south pier 250 feet. The total pier extension under this contract was 550 feet, 50 feet of the south pier having been completed June 23, 1893.

By hired labor and the use of United States dredge No. 2, dredging was begun August 3 and closed September 14, 1893, resulting in the removal of 22,425 cubic yards of material and the formation of a channel centrally located between the piers 120 feet wide and 14 feet deep, and a turning basin of the same depth in the old river bed. Repairs were also made to the harbor piers and dredging plant.

Remarks and recommendations.—Many vessels of light draft obtain shelter at this harbor during the prevalence of severe gales. If the piers were completed the full length contemplated, the number of vessels seeking shelter here would be largely increased.

Each pier requires an extension of about 400 feet, as the 18-foot contour has advanced about 200 feet since the improvement was begun in 1881, but no increase of the original estimate is necessary. The protection of the river front by docks completed by private parties during the past year, and other docks in process of construction, will be of great benefit to the harbor and decrease the cost of maintenance.

Should an appropriation be made for the fiscal year ending June 30, 1896, it is contemplated to expend it chiefly in pier construction. An appropriation of $75,000 is recommended.

Estimated cost (see Report of Chief of Engineers, 1881, p. 2084)	$200,000

APPROPRIATIONS.

Act of—	
March 3, 1881	$5,000.00
August 2, 1882	12,000.00
July 5, 1884	18,000.00
August 5, 1886	10,000.00
August 11, 1888	10,000.00
September 19, 1890	20,000.00
July 13, 1892	30,000.00
Miscellaneous receipts credited to appropriations	14.00
Total	105,014.00
Appropriated by local authorities in 1881, and expended by the United States under the direction of the engineer officer in charge	8,042.72

Money statement.

July 1, 1893, balance unexpended	$23,949.60
June 30, 1894, amount expended during fiscal year	23,374.60
July 1, 1894, balance unexpended	575.00
Amount (estimated) required for completion of existing project	86,943.28
Amount that can be profitably expended in fiscal year ending June 30, 1896	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

List of materials used and cost of same in place for the construction of 550 linear feet of pile pier at Kewaunee Harbor, Wisconsin, under contract with Mr. John M. Borgman, dated August 27, 1892.

Articles.	Quantities.	Price per unit.	Amount.
Round piles furnished and driven ....linear feet..	34, 876	$0. 20	$6, 875. 20
Pine timber 12 by 12 inches ....feet, B. M..	15, 552	22. 00	342. 14
Pine timber 6 by 12 inches ....do....	6, 780	24. 00	162. 72
Pine sheet pile plank, 3 by 12 inches by 28 feet ....do....	92, 736	29. 00	2, 689. 34
White oak timber, 6 by 12 inches and 10 by 12 inches ....do....	37, 896	47. 00	1, 781. 11
Pine deck plank 3 by 12 inches by 16 feet ....do....	21, 528	15. 00	322. 92
Screw bolts, tie-rods, nuts, and washers ....pounds..	19, 767	. 04½	889. 51
Wrought iron spikes ....do....	2, 622	. 04	104. 88
Stone ....cords..	1, 870	4. 90	9, 163. 00
Total			22, 330. 82

North pier: Extended 250 feet; cost, $10,926.60; average cost per linear foot, $43.70.
South pier: Extended 300 feet; cost, $11,404.22; average cost per linear foot, $38.01.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1883.

[Furnished by the mayor of Kewaunee, Wis.]

Name of harbor, Kewaunee, Wis.; collection district, Milwaukee, Wis.; nearest light-house on north pier head, Kewaunee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	1, 010	644, 801	1, 026	643, 542
Sail	220	15, 562	227	15, 783
Total	1, 230	660, 363	1, 253	659, 325

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Agricultural implements	3	Agricultural implements	75
Apples	9	Apples	172
Bark, tan	1, 320	Beans	6
Barley	504	Beer	52
Beans	6	Cattle	15
Beer	13	Chairs	16
Brick	12, 000	Coal and coke	1, 000
Butter	125	Corn	34
Cattle	900	Flour	69, 875
Cheese	500	Iron and steel	275
Eggs	52	Laths	27
Fish	10	Leather	17
Flour	75, 250	Lime and cement	180
Furniture	1	Lumber	6, 000
Hay	3, 000	Malt	5
Hides	12	Marble	3
Hogs	40	Merchandise, general	6, 000
Iron and steel	28	Mill stuffs	400
Lumber	112	Oil	450
Merchandise, general	22, 000	Pease	5
Mill stuffs	3, 500	Plaster, land	500
Oats	352	Pork and beef	66
Pease	6, 000	Potatoes	4
Plaster, land	2, 500	Salt	1, 800
Pork and beef	36	Sash, doors, and blinds	20
Posts, fence	1, 615	Sheep	5
Potatoes	99	Shingles	82
Provisions	1	Stone	7, 000
Rye	99	Wagons and carriages	250

Principal articles of export and import—Continued.

BY WAY OF THE HARBOR ONLY—Continued.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS—continued.	*Tons.*	IMPORTS—continued.	*Tons.*
Salt	120	Wheat	360
Sash, doors, and blinds	1	Wood	625
Sheep	120	Wooden ware	4
Stone	21,000		
Ties, railroad	3,500	Total	95,323
Wagons and carriages	12		
Wheat	900	Total approximate value	$3,032,850
Wood	250		
Wool	15		
Total	156,005		
Total approximate value	$4,304,710		

J J 13.

IMPROVEMENT OF TWO RIVERS HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Twin Rivers, where the harbor of Two Rivers is situated.

Project.—The project for the improvement of this harbor, adopted in 1870, provided for the construction of two parallel piers extending from the river mouth to the 18-foot contour in Lake Michigan, and dredging between them to a depth of 12 feet.

Present works.—Pile and crib piers: (1) north pier, 1,810 feet long, composed of 1,060 feet of pile pier 14 feet wide and 750 feet of cribs 20 feet wide; (2) south pier, 1,710 feet long, composed of 960 feet of pile pier 14 feet wide and 750 feet of cribs 20 feet wide. The pile piers were built in 1871–1874 and the cribs in 1875–1884. The latter are in good condition. The timber superstructure of the pile piers is much decayed and should be rebuilt at an early day.

Depth of water.—Originally from 2 to 3 feet. Soundings taken April 5, 1894, showed a governing depth in the entrance channel of about 11 feet.

Operations during the fiscal year.—By hired labor and purchase of materials in open market, minor repairs were made to the piers, viz, 15.2 cords of stone filling were placed in the outer end of the north pile pier, and the plank walk was repaired; defective waling pieces to the sheet piling of the south pier were removed and new wales put on; repairs were also made to the sand fences.

Dredging with United States dredge No. 2 was in progress at the beginning of the fiscal year and continued until July 31, 1893. Eleven thousand seven hundred and sixty-five cubic yards of material were removed from the channel during the fiscal year, making a total of 28,205 cubic yards during the working season of 1893.

Remarks and recommendations.—The steam tugs at this harbor are employed in the fishing trade and towage of rafts from the northern end of Lake Michigan and Green Bay, therefore they are not available for towing sailing vessels seeking entrance into the harbor; hence when the wind is unfavorable they are obliged to "beat" in. Water being shoal near the shore ends of the harbor piers, they sometimes touch bottom when well inside the harbor entrance. It will therefore be desirable to dredge the channel 12 feet deep the full width between the piers.

To accomplish this the removal of about 25,000 cubic yards of material is necessary.

Arrangements have been made with the Goodrich Transportation Company for their west shore line of steamers to stop at this harbor, thus establishing a daily line north and south.

The superstructure of the pile piers, 2,020 linear feet, requires renewal. It was built in 1871-1873, is much decayed, and in a dilapidated condition.

Estimate for 1896.

For rebuilding 2,020 feet of pile pier above the water line, at $6.50	$13,130
For dredging	4,000
Contingencies	1,670
Total	18,800

For the formation of a wider channel, maintenance of the same, and rebuilding decayed superstructure, an appropriation of $18,800 is recommended for the fiscal year ending June 30, 1896.

Estimated cost (see Report of Chief of Engineers, 1871, p. 123) $265,588.80

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$25,000	March 3, 1881	$15,000
June 10, 1872	25,000	August 2, 1882	15,000
March 3, 1873	25,000	July 5, 1884	8,000
June 23, 1874	15,000	August 11, 1888	2,500
March 3, 1875	15,000	September 19, 1890	3,000
August 14, 1876	5,000	July 13, 1892	3,000
June 18, 1878	10,000	Total	206,500
March 3, 1879	20,000		
June 14, 1880	20,000		

Money statement.

July 1, 1893, balance unexpended	$2,012.29
June 30, 1894, amount expended during fiscal year	1,461.36
July 1, 1894, balance unexpended	550.93
Amount (estimated) required for completion of existing project	59,088.80
Amount that can be profitably expended in fiscal year ending June 30, 1896	18,800.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. James E. Hamilton, mayor.]

Name of harbor, Two Rivers, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on north pier-head, Two Rivers, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	67	39,436	67	39,436
Fish tugs	1,800	22,000	1,800	22,000
Sail	70	18,719	70	18,719
Total	1,937	80,155	1,937	80,155

Principal articles of export and import.

BY WAY OF HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Agricultural implements	20	Agricultural implements	112
Apples	56	Apples	176
Barley	159	Brick	5,000
Beans	6	Chairs	20
Beer	166	Cheese	4
Brick	85	Coal and coke	50,000
Butter	26	Corn	617
Chairs	4,750	Fish	8
Cheese	87	Flour	669
Eggs	19	Furniture	394
Fish	1,125	Iron and steel	1,225
Flour	322	Lath	1,925
Furniture	8,437	Leather	7
Hay	5,750	Lime and cement	47
Hides	26	Lumber	1,200
Hogs	45	Merchandise, general	890
Lumber	6,000	Oil	1,620
Merchandise, general	1,475	Pork and beef	94
Pease	450	Provisions	12
Potatoes	452	Salt	675
Provisions	13	Sash, doors, and blinds	630
Wood type	156	Saw logs	875,000
Wooden ware	12,778	Shingles	1,575
Wool	6	Stone	12,600
		Wagons and carriages	37
Total	42,359	Wood	20,000
Total approximate value	$2,450,000	Total	474,567
		Total approximate value	$3,750,000

BY ALL WAYS OF TRANSPORTATION.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS—continued.	*Tons.*
Agricultural implements	48	Brick	7,480
Apples	56	Chairs	37
Barley	193	Cheese	5
Beans	9	Coal and coke	93,000
Beer	221	Corn	1,008
Brick	600	Fish	12
Butter	31	Flour	905
Cattle	900	Furniture	259
Chairs	11,750	Iron and steel	2,086
Cheese	162	Lath	2,888
Eggs	36	Leather	10
Fish	2,000	Lime and cement	94
Flour	537	Lumber	2,656
Furniture	16,875	Marble	11
Hay	22,000	Merchandise (general)	18,650
Hides	28	Mill stuffs	275
Hogs	50	Oats	140
Lumber	13,500	Oil	3,269
Merchandise (general)	2,875	Plaster (land)	133
Pease	1,140	Pork and beef	216
Potatoes	752	Poles (telegraph)	23
Provisions	24	Posts (fence)	95
Rye	532	Provisions	42
Sheep	32	Salt	1,059
Wheat	66	Sash, doors and blinds	900
Wood type	459	Saw logs	408,000
Woodenware	20,708	Shingles	2,250
Wool	31	Stone	12,600
		Ties (railroad)	210
Total	95,615	Wagons and carriages	79
		Wheat	360
Total approximate value	$4,100,765	Wood	21,240
		Woodenware	22
IMPORTS.		Total	580,456
Agricultural implements	187		
Apples	255	Total approximate value	$7,000,000

J J 14.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Manitowoc River, where the harbor of Manitowoc is situated.

Project.—The original project, adopted in 1852, provided for the construction of two parallel crib piers, 220 feet apart, extending from the mouth of the Manitowoc River to the 12-foot contour in Lake Michigan. It was completed in 1871. In 1881, to meet the increased demands of commerce, a project was adopted for extending the piers to the 18½-foot contour and obtaining a channel of not less than 14 feet depth at the shore line, increasing to 18 feet at the entrance. Pier extension under this project was completed in 1887 and the dredging in 1889.

In 1890 a project for an exterior breakwater 400 feet long was submitted.

Present works.—Crib piers: (1) North pier, 1,970 feet long, composed of 1,220 feet of cribs 20 feet wide and 750 feet 24 feet wide; (2) south pier, 1,900 feet long, composed of 1,150 feet of cribs 20 feet wide and 750 feet 24 feet wide.

Depth of water.—Originally 3 feet. A survey completed April 1, 1894, showed the depth at entrance to be from 16½ to 17 feet, but the governing depth between the piers did not exceed 14 feet.

Operations during the fiscal year.—By hired labor and purchase of materials in open market 592 linear feet of the south pier were rebuilt above the water line. Minor repairs were also made to the plank decking of the cribs.

Remarks and recommendations.—The north pier was completed in 1885, the south pier in 1887, and the dredging in 1889.

For the restoration of the channel the excavation of 17,000 cubic yards of material is now needed, and a small amount of dredging will be required from time to time for its maintenance. The renewal, above the water line, of 320 linear feet of the older portion of the piers is needed; also 100 cords of stone for additional filling to superstructure rebuilt in 1893.

No work has been done on the breakwater, it not being considered judicious to begin the same until sufficient funds are available to complete it, as if left in an incomplete condition it would be liable to damage and a menace to life and property.

Estimate for 1896.

Restoration and maintenance of channel	$4,000
Rebuilding above the water line 320 linear feet of pier	3,200
Additional stone filling for superstructure built in 1893	600
For construction of breakwater	40,000
Total	47,800
Less balance now available, about	22,800
Estimated amount required to be appropriated	25,000

To supplement funds now available an appropriation of $25,000 is therefore recommended for fiscal year ending June 30, 1896.

Estimated cost (see Report of Chief of Engineers, 1861, p. 2094	$308,182.54
Additional estimate for breakwater (see Report of Chief of Engineers, 1890, p. 2345)	40,000.00
Total	348,182.54

APPROPRIATIONS.

Act of—	
August 30, 1852	$8,000.00
June 23, 1866	52,000.00
March 2, 1867	45,000.00
July 25, 1868 (allotted)	17,500.00
April 10, 1869 (allotted)	17,820.00
July 11, 1870	20,000.00
March 3, 1871	11,000.00
March 3, 1873	20,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	8,000.00
June 18, 1878	15,000.00
March 3, 1879	6,500.00

Act of—	
June 14, 1880	$7,000.00
March 3, 1881	4,000.00
August 2, 1882	10,000.00
July 5, 1884	15,000.00
August 5, 1886	15,000.00
August 11, 1888	8,000.00
September 19, 1890	8,000.00
July 13, 1892	28,000.00
Miscellaneous receipts credited to appropriations	220.50
Total	336,040.50

Money statement.

July 1, 1893, balance unexpended	$26,651.93
June 30, 1894, amount expended during fiscal year	3,788.10
July 1, 1894, balance unexpended	22,863.83
Amount (estimated) required for completion of existing project	25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

List of materials used and cost of same in place for rebuilding above the water line 592 linear feet of the south harbor pier at Manitowoc, Wis.

Articles.		Quantities.	Price per unit.	Amount.
White pine timber	feet, B. M.	112,128	$16.75	$1,878.14
Pine plank	do	6,000	16.75	100.50
Iron driftbolts	pounds	7,475	$.02\frac{15}{100}$	160.71
Iron spikes	do	300	$.02\frac{3}{4}$	8.25
Stone	cords	76.7	5.50	421.85
Tools and appliances				45.26
Pay rolls for labor				450.50
Total				3,065.21

Cost per running foot, $5.18.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. Joseph Vilas, mayor.]

Name of harbor, Manitowoc, Wis.; collection district, Milwaukee, Wis.; neares light-house on north pier head, Manitowoc, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	611	368,315	610	367,401
Sail	277	47,773	276	48,193
Total	888	416,088	886	415,594

Principal articles of export and import

BY WAY OF THE HARBOR ONLY.

Articles.	Quanitty.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Agricultural implements	27	Agricultural implements	1, 525
Apples	71	Apples	95
Barley	188	Bark, tan	440
Beans	36	Barley	840
Beer	52	Coal and coke	162, 140
Brick	1, 400	Corn	38
Butter	157	Fish	9
Cattle	176	Flour	20
Cheese	1, 575	Hides	141
Coal and coke	21, 000	Iron and steel	4, 630
Eggs	145	Lath	244
Fish	33	Leather	18
Flour	42, 247	Lime and cement	792
Furniture	147	Lumber	8, 157
Hay	7, 986	Marble	79
Hides	43	Merchandise, general	20, 630
Hogs	71, 000	Mill stuffs	50
Leather	68	Oil	225
Malt	1, 000	Salt	285
Merchandise, general	2, 950	Shingles	495
Mill stuffs	8, 086	Stone	8, 367
Oats	1, 229	Wagons and carriages	19
Pease	3, 270	Wood	1, 265
Pork and beef	14		
Potatoes	900	Total	205, 504
Rye	353		
Salt	1, 500	Total approximate value	$3, 200, 000
Sheep	6		
Wagons and carriages	92		
Wheat	900		
Wool	34		
Total	161, 685		
Total approximate value	$2, 500, 000		

BY ALL WAYS OF TRANSPORTATION.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS.	*Tons.*
Agricultural implements	764	Agricultural implements	2, 110
Apples	81	Apples	167
Barley	2, 180	Bark, tan	1, 760
Beans	45	Barley	11, 186
Beer	166	Beer	175
Brick	3, 630	Coal and coke	230, 700
Butter	206	Corn	1, 727
Cattle	294	Fish	10
Cheese	1, 605	Flour	42, 892
Coal and coke	221, 000	Hides	92
Eggs	199	Iron and steel	4, 765
Fish	34	Lath	247
Flour	42, 570	Leather	22
Furniture	224	Lime and cement	924
Hay	9, 949	Lumber	7, 725
Hides	8	Marble	20
Hogs	45	Merchandise, general	43, 771
Leather	167	Mill stuffs	2, 032
Malt	5, 993	Oil	652
Merchandise, general	7, 197	Plaster, land	1, 000
Mill stuffs	3, 286	Salt	2, 700
Oats	1, 437	Shingles	600
Pease	5, 783	Stone	4, 648
Plaster, land	300	Wagons and carriages	112
Pork and beef	19	Wheat	600
Potatoes	914	Wood	19, 407
Rye	913		
Salt	2, 400	Total	380, 044
Sheep	6		
Wagons and carriages	362	Total approximate value	$6, 900, 000
Wheat	2, 610		
Wool	36		
Total	314, 423		
Total approximate value	$6, 974, 545		

J J 15.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Sheboygan River, where the harbor of Sheboygan is situated.

Project.—The project for the improvement of this harbor was adopted in 1852, and had for its object the formation of a 12-foot channel entrance to the mouth of the Sheboygan River. This was modified in 1873 so as to secure a deeper channel by further pier extension and dredging. Both projects were completed within their estimated cost, and a channel was formed 100 feet wide, with a depth of 15 to 16 feet between the piers. A survey made in 1880 showed a depth of less than 12 feet between the piers and on the outer bar. The existing project was adopted in 1881, its object being to deepen the channel still further by extending the piers to the 20-foot contour in the lake and dredging to a depth of 18 feet between their outer ends, the depth decreasing to 14 feet at the shore line.

Present works.—Pile and crib piers: (1) North pier, 2,370 feet long, composed of 900 feet of pile and crib pier, built by the city, from 12 to 20 feet wide; 1,320 feet of cribs 20 feet wide, 100 feet of cribs 24 feet wide, and 50 feet of cribs 30 feet wide. (2) South pier, 2,487 feet long, composed of 780 feet of pile and crib pier, built by the city, from 12 to 20 feet wide; 132 feet of pile pier 20 feet wide; 1,525 feet of cribs 20 feet wide, and 50 feet of cribs 30 feet wide, built 1852–1893. About 950 feet of the north pier and 1,000 feet of the south pier, built since 1871, are in good condition, the cribs having been sunk on a stone foundation. Previous to 1871 they were sunk on the natural lake bottom, composed of shifting sand, causing them to settle very unevenly.

Depth of water.—Originally 4 feet. A survey completed March 28, 1894, showed a channel situated midway between the piers of navigable width and a governing depth of about 15.6 feet.

Operations during the fiscal year.—Under contract dated September 29, 1892, with Mr. D. A. McLeod, of Manistee, Mich., for extending each pier 100 feet by cribs 24 feet wide in extension of the north pier and 20 feet wide for the south pier, provided with pile foundations and superstructure complete, work was in progress at the beginning of the fiscal year, but no cribs had been sunk in place.

Work under this contract was completed August 17, 1893, and the contract closed, resulting in the extension of each pier 100 feet.

By hired labor and purchase of materials in open market the piers were refilled and riprapped with 100.6 cords of stone in places where undue settlement had occurred, and boltheads that projected into the channel were covered with oak plank to prevent damage to passing vessels.

Remarks and recommendations.—A short line of railroad is in process of construction that will connect Sheboygan with the Chicago, Milwaukee and St. Paul Railway system, consisting of over 6,000 miles of track. Its completion at an early day is expected to add largely to the trade and commerce of Sheboygan and its harbor.

A channel of less than 16 feet in depth does not meet the present requirements of this harbor, and as soon as the 20-foot channel between Buffalo and Chicago is completed that depth will be needed here also.

This improvement was begun in 1852, under the supervision of harbor commissioners appointed by the town and county of Sheboygan.

In 1854 the piers built by them terminated in 10½ feet depth of water;

from natural causes the depth decreased from 10½ feet in 1854 to about 3 feet at the end of the north pier and 6 feet at the end of the south pier in 1893.

The cribs were built of hewn timber, poorly constructed, sunk on the natural lake bottom, settled very unevenly, and consequently admit an undue quantity of sand to pass through them into the channel, the result being that the dredging required to maintain a channel of the requisite dimensions is largely in excess of what it should be.

The United States assumed control of these piers about 1866, have renewed the superstructure and made minor repairs to them from time to time.

Various plans have been considered for their thorough reconstruction, but owing to the urgent necessity of extending the piers in accordance with the project adopted in 1881 no plan has been submitted.

Pier extension under the contract completed in 1893, so nearly completes the extension contemplated under the existing project, that the reconstruction of the shore ends of the piers is now of paramount importance.

The method of repairs contemplated consists chiefly in taking up the inner section of the south pier and rebuilding the same on a line in prolongation of the pier built under the project adopted in 1881, thereby giving a uniform width of entrance of about 270 feet.

I am informed by Hon. George H. Brickner, M. C., that the city of Sheboygan, by ordinance duly approved by the mayor, has "undertaken and agrees to secure all necessary lands needed for so widening the harbor, either by purchase or condemnation proceedings, and to dedicate the same to the United States for harbor purposes, if requested, provided the Government will remove the old piers and build new piers on the south side, as above proposed, and dredge between piers."

The United States will therefore be at no expense for right of way in relocating the inner end of the south pier upon the proposed line.

Should an appropriation be made for the fiscal year ending June 30, 1896, it is proposed to expend it in such dredging and repairs as may be necessary for the maintenance and improvement of the channel and piers, and in pier extension if the amount appropriated should be sufficiently large to admit of it. An appropriation of $106,900 is recommended, of which sum $64,900 is for maintenance and repairs.

Estimated cost of the present project, adopted in 1881 (see Report of Chief of Engineers, 1881, p. 2104)	$150,000.00
Additional estimate (see Report of Chief of Engineers, 1884, p. 1856)	45,000.00
Total	195,000.00

APPROPRIATIONS.

Act of—	
August 30, 1852	$10,000.00
June 28, 1864 (allotted)	10,000.00
June 23, 1866	47,598.91
March 2, 1867	8,000.00
April 10, 1869 (allotted)	14,850.00
July 11, 1870	15,000.00
March 3, 1871	15,000.00
June 10, 1872	18,000.00
March 3, 1873	10,000.00
June 23, 1874	10,000.00
March 3, 1875	12,000.00
August 14, 1876	6,000.00
June 18, 1878	$4,000.00
March 3, 1879	3,000.00
June 14, 1880	7,000.00
March 3, 1881	25,000.00
August 2, 1882	30,000.00
July 5, 1884	28,000.00
August 5, 1886	15,000.00
August 11, 1888	15,000.00
September 19, 1890	15,000.00
July 13, 1892	25,000.00
Total	343,448.91

Money statement.

July 1, 1893, balance unexpended	$18,371.52
June 30, 1894, amount expended during fiscal year	15,861.12
July 1, 1894, balance unexpended	2,510.40
Amount (estimated) required for completion of existing project	106,900.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	106,900.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

List of materials used and cost of same in place for extending the north pier at Sheboygan, Wis., 100 feet by cribs 24 feet wide and 22½ feet high, and the south pier 100 feet by cribs 20 feet wide and 20½ feet high, including superstructure, under contract dated September 29, 1892, with Mr. D. A. McLeod, of Manistee, Mich.

Articles.		Quantities.	Price per unit.	Amount.
Pine timber	feet, B. M.	150,720	$24.00	$3,617.28
Hemlock timber	do	131,448	17.50	2,300.34
Pine plank	do	12,870	17.00	218.79
Foundation piles	Number	104	10.50	1,092.00
Iron driftbolts	pounds	23,815.7	.04	952.62
Iron screw-bolts	do	4,452.8	.04	178.11
Iron spikes	do	705	.04	28.20
Stone	cords	838.3	7.00	5,868.10
Total				14,255.44

	Per linear foot.	Total.
North Pier:		
Cost of 2 cribs, each 50 by 24 by 16½ feet	$57.34	$5,734.54
Cost of superstructure, 6 feet high	20.72	2,072.04
Total	78.06	7,806.58
South Pier:		
Cost of 2 cribs, each 50 by 20 by 14½ feet	47.22	4,722.16
Cost of superstructure 6 feet high	17.27	1,726.70
Total	64.49	6,448.86

COMMERCIAL STATISTICS.

Repeated but unsuccessful efforts were made to obtain commercial statistics of this important harbor for the calendar year ending December 31, 1893. Therefore the statistics furnished last year are repeated.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1892.

[Furnished by Col. J. A. Watrous, collector of customs, Milwaukee, Wis., and Mr. Frank Geele mayor of Sheboygan, Wis.]

Name of harbor, Sheboygan, Wis. Collection district, Milwaukee, Wis. Nearest light-house, Sheboygan, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	550	355,584	562	355,605
Sail	645	74,508	616	73,675
Total	1,195	430,092	1,178	429,280

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.		IMPORTS—continued.	
	Tons.		*Tons.*
Boots, shoes, and rubbers	520½	Corn	672
Chair irons	1,500	Fish	1,000
Chairs	60,076	Furniture	3¾
Cheese	1,500	Hardware, furniture trimmings	282
Enameled ware	575	Hardware, retail and wholesale	500
Fish	400	Hides	2,500
Furniture	6,390	Iron and steel	180
Leather	900	Lath	550
Lime and cement	43,500	Leather	250
Mineral water	750	Lime and cement	29
Pease	240	Lumber	55,248
Toys	450	Oats	1,600
Veneers	1,000	Oils, paints, varnishes, etc., factory consumption	794½
Wooden ware	900	Post, paving	1,900
Total	118,101½	Potatoes	60
		Salt	1,500
Total approximate value	$2,861,666	Shingles	1,260
		Stone	7,000
IMPORTS.		Wood	20,000½
Agricultural implements	25	Total	220,866½
Bark, tan	5,500		
Chairs	11½	Total approximate value	$2,374,845
Coal and coke	120,000		

BY ALL WAYS OF TRANSPORTATION.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.		IMPORTS—continued.	
	Tons.		*Tons.*
Boots, shoes, and rubbers	1,562½	Furniture	61½
Chair irons	500	Hay	9,000
Chairs	15,018	Hardware, furniture trimmings	846½
Cheese	9,000	Hardware, retail and wholesale	1,500
Coal and coke	50,000	Hides	7,500
Enameled ware	1,725	Iron and steel	1,800
Fish	1,000	Lath	825
Furniture	31,980	Leather	250
Leather	4,550	Lime and cement	76½
Lime and cement	101,500	Lumber	126,120
Malt	1,250	Marble	25
Mineral water	1,250	Merchandise, general	2,500,000
Pease	240	Mill stuffs	240
Toys	675	Oats	2,400
Veneers	1,500	Oils, paints, varnishes, etc., factory consumption	2,534
Woodenware	2,250	Plaster, land	350
Wood-working machines	600	Pork and beef	18,000
Total	224,600½	Posts, paving	1,900
		Potatoes	90
Total approximate value	$7,753,000	Rubbers	312½
		Salt	1,500
IMPORTS.		Sash, doors, and blinds	150
		Shingles	1,890
Agricultural implements	75	Sewer pipe	375
Bark, tan	5,500	Stone	8,456
Barley	7,990	Wagons and carriages	50
Beer	3,100	Wheat	1,500
Brick	1,000	Wood	27,650
Chairs	23		
Cheese	900	Total	2,854,989¾
Coal and coke	120,000		
Fish	1,000	Total approximate value	$8,649,318

J J 16.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

Object.—To secure a navigable channel entrance from Lake Michigan to a small artificial harbor formed by excavating two interior connected basins.

Project.—The original project for the improvement of this harbor was adopted in 1869, and provided for the building of 2 parallel piers, 150 feet apart, extending from the shore line to 10 feet of water in the lake, and the excavation of a basin 600 feet long by 200 feet wide inside of the shore line. In 1876 a modification of the plan was made by excavating a second basin to the northward and nearly at right angles to the first basin, and extending the pier to the 14-foot contour in the lake. This doubled the available area of the harbor and reduced the height of the entering waves very materially.

This is the project now being carried out. The two interior basins have a combined area of about 5¾ acres, and are to be dredged to a depth of 12 feet, with a channel of the same depth connecting them with the lake.

Present works.—(1) North pier, 920 feet long, composed of 370 feet of cribs 14 feet wide; 500 feet, 20 feet wide, and 50 feet, 24 feet wide. (2) South pier, 1,326 feet long, composed of 370 feet of cribs 14 feet wide; 550 feet, 20 feet wide, and 406 feet of pile revetment. The piers were built in 1871-1893 and are in good condition, with the exception of 640 linear feet of superstructure, built in 1871, which is much decayed and requires renewal.

Depth of water.—The original depth of water at the mouth of Sauk River was about 1 foot. Soundings taken in March, 1894, showed the governing depth in the entrance channel to be about 10 feet. Over most of the area of the north basin there is a depth of from 11½ to 12 feet. The north half of the west basin has a depth of 11 to 12 feet, and an average depth of about 4 feet in the south half.

Operations during the fiscal year.—By hired labor and purchase of materials in open market minor repairs were made to the north pier head in September, 1893, it having been damaged by the ice. The outer pockets of the crib were also refilled with stone taken from the shore end of the pier.

In March, 1894, the north pier head was again refilled with stone, it being found that undue settlement had occurred during the winter.

Remarks and recommendations.—The north pier was built the full length contemplated in 1887, and the south pier in 1893.

From September, 1890, to May, 1892, there was a deposit in the channel and basins of about 7,000 cubic yards of material, reducing the depth of water in the entrance channel about 1½ feet. On the last mentioned date the removal of about 13,000 cubic yards of material was necessary. The soundings taken March 30, 1893, showed that an additional deposit of about 9,000 cubic yards had taken place, making the total quantity of dredging then required 22,000 cubic yards.

The estimated quantity of material to be excavated to complete the dredging, based on a survey made in March, 1894, is 30,000 cubic yards.

Three hundred and twenty linear feet of the shore end of each pier, built in 1871, have seen twenty-three years' service. The superstructure of this portion of the piers is badly decayed, and should be rebuilt above the water line. The estimated cost of the dredging and rebuilding 640 linear feet of superstructure is $12,000.

Should an appropriation be made for the fiscal year ending June 30, 1896, it is contemplated to expend it for dredging and rebuilding above the water line the shore ends of the north and south piers. An appropriation of $12,000 is recommended for maintenance of channel and piers.

Estimated cost (see Report of Chief of Engineers, 1877, p. 866)	$154,527.17
Additional estimate (see Report of Chief of Engineers, 1880, p. 1922)	27,000.00
Additional estimate (see Report of Chief of Engineers, 1891, pp. 2551-2552)	2,472.83
Total	184,000.00

APPROPRIATIONS.

Act of—		Act of—	
July 11, 1870	$15,000.00	August 2, 1882	$17,000.00
March 3, 1871	15,000.00	July 5, 1884	10,000.00
June 10, 1872	15,000.00	August 5, 1886	5,000.00
March 3, 1873	15,000.00	August 11, 1888	5,000.00
June 23, 1874	10,000.00	September 19, 1890	3,000.00
March 3, 1875	10,000.00	July 13, 1892	6,500.00
August 14, 1876	8,000.00	Miscellaneous receipts credited to appropriations	36.50
June 18, 1878	5,000.00		
March 3, 1879	7,500.00		
June 14, 1880	20,000.00		
March 3, 1881	17,000.00	Total	184,036.50

Money statement.

July 1, 1893, balance unexpended	$285.45
June 30, 1894, amount expended during fiscal year	63.00
July 1, 1894, balance unexpended	222.45
Amount (estimated) required for completion of existing project	12,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	12,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Mr. Charles A. Mueller, harbor master.]

Name of harbor, Port Washington, Wis.; collection district, Milwaukee, Wis.; nearest light-house, on outer end of north pier, Port Washington, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	68	8,375	67	8,220
Sail	132	16,320	132	16,320
Total	200	24,695	199	24,540

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.		IMPORTS.	
	Tons.		*Tons.*
Agricultural implements	1,250	Agricultural implements	150
Apples	187	Bark, tan	1,936
Barley	3,525	Chairs	22½
Beans	24	Coal and coke	5,700
Beer	122½	Furniture	10
Brick	3,000	Hides	640
Butter	100	Iron and steel	1,600
Chairs	3,250	Lath	550
Cheese	125	Lumber	16,000
Corn	175	Marble	150
Eggs	15	Merchandise, general	19,000
Fish	400	Oil	560
Flour	250	Plaster, land	250
Furniture	1,125	Pork and beef	15
Hay	400	Posts fence	47½
Hogs	25	Provisions	100
Leather	400	Salt	675
Lime and cement	2,375	Shingles	300
Malt	2,500	Stone	18,900
Merchandise, general	1,200	Wagons and carriages	69
Millstuffs	850	Wheat	30,000
Oats	48	Wood	11,250
Pease	24		
Potatoes	350	Total	107,924
Provisions	60		
Sash, doors, and blinds	120	Total approximate value	$1,324,000
Woodenware	525		
Wool	7½		
Total	22,433		
Total approximate value	$972,000		

J J 17.

HARBOR OF REFUGE AT MILWAUKEE BAY, WISCONSIN.

Object.—To provide a secure anchorage for vessels engaged in the general commerce of the lakes by inclosing the northern section of Milwaukee Bay within a breakwater formed of timber crib work, placed and sunk upon a foundation of stone.

Project.—The project was adopted in 1881 and provided for the construction of a breakwater, the north arm of which commences at a distance of about 600 feet from the north shore of the bay in a depth of 8 feet of water. Its direction is south 25° 19′ east, and its length 2,450 feet. From this point the direction of the main arm of the breakwater is changed to south 11° west for the proposed distance of 5,200 feet, with an opening of 400 feet at the distance of 1,000 feet from the angle, to provide a fair-weather entrance and exit for vessels.

Present works.—The north arm of the breakwater is completed. The most northerly section of it, 600 feet in length, is comprised of six cribs, each 100 feet long and 20 feet wide, and the remaining 1,850 feet of thirty-seven cribs, each 50 feet long by 24 feet wide.

The dimensions of the cribs forming the main arm to the northward of the opening are 50 feet by 24 feet by 22½ feet, with the exception of Crib No. 62, which is next to or immediately northward of the opening, and is 100 feet long by 24 feet wide by 22½ feet high. Over all of these superstructure has been built to a height 5½ feet above datum.

Eight cribs, numbered from 63 to 70 inclusive, each of dimensions 100 by 24 by 22½ feet, have been sunk to the southward of the opening, over 700 feet of which superstructure has been built.

The total length of substructure built is 4,250 feet, upon which 4,150 feet of superstructure has been built.

Depth of water.—The slope of the lake bed from the northern end of the breakwater to the angle formed by the north and main arm is 0.87 foot to 100 feet, the angle crib being set in 29.4 feet of water. The average depth of water on the line of section of main arm to the southward of the opening is 34.6 feet.

Operations during the fiscal year.—The river and harbor act of July 13, 1892, appropriated $75,000 for continuing the work, and on October 18, 1892, a contract was entered into with Mr. D. A. McLeod, of Manistee, Mich., for extending the breakwater 500 running feet and for building 300 feet of superstructure on cribs already sunk in place. But on April 19, 1893, while the first crib called for by the contract was in process of construction, a storm occurred in which two 50-foot cribs (Nos. 47 and 48) were overturned and 1,500 linear feet of superstructure of the outer arm were badly injured. It was important that the wrecked superstructure should be repaired before the occurrence of another storm; and it was also apparent that the section of the outer arm, without extensive reenforcement, could no longer be considered safe. To make the necessary repairs and to strengthen the work a supplementary agreement was entered into with the contractor under which the crib then constructing was to be sunk in extension of the breakwater, another crib, also 100 feet long, but 18½ instead of 22½ feet high, was to be constructed and sunk in the gap left by the overthrow of Nos. 47 and 48; 400 linear feet of new superstructure (stronger than the old) were to be constructed over Cribs 67, 68, 69, and the new Crib 47-48; 1,500 linear feet of old superstructure were to be repaired and strengthened, and stone was to be deposited along both sides of the outer arm, 1,950 feet in length, so as to raise the riprap to within 13 feet of the water surface, with bermes of 5 and 8 feet, and slopes of 1 on 1½ and 1 on 1 on the lake and harbor sides respectively. The reenforcement of the superstructure consisted in putting in corner posts at alternate tiers of ties and fastening them with screw bolts to the ties and to the side walls, and in decking the superstructure with 6 by 8 timbers laid transversely. Work under this contract was finished November 20, 1893, and the breakwater is now believed to be secure.

The scow *Dunham* has been reengaged to serve as a light-ship at the south end of the breakwater under a new agreement with her owner.

Remarks and recommendations.—The shore accretions which have formed in the northern end of the harbor, especially since the construction in 1887 of the piers of the flushing tunnel intake, are large, but the anchorage area beyond the 18-foot contour is not as yet materially reduced. The project adopted by the board of engineers constituted by Special Orders, No. 32, paragraph 2, headquarters Corps of Engineers, dated April 7, 1881, was as follows:

> Starting from near North Point, in 8 feet of water, but leaving a gap of about 600 feet between the beginning of the breakwater and the shore, to be closed hereafter if found necessary, etc.

As there can be no doubt that it is by way of this gap that the sand-bearing currents enter the harbor, the necessity for closing the gap is apparent. A row of sheet piling supported by main piles and binders would effect this at a cost of about $12 per linear foot, or in all about $4,800.

At the rate at which the breakwater has been constructed—about 327 feet per year—nine years will be required to finish it. At the rate at which appropriations have been made it will take even longer, on account of the increasing depth and exposure, perhaps fifteen years. Again, the larger the appropriations and therefore the amount of work to be done under any one contract, the more favorable the prices. For economical reasons, then, if for no other, the appropriations ought to be larger than those heretofore made. Moreover, experience has shown that the section heretofore adopted is of insufficient strength for the portion of the breakwater which remains to be constructed, and that either the width of cribs used must be increased to, say, 30 feet, or else recourse must be had to some other type of construction equivalent in stability. It was the opinion of the original board (Report of 1881, p. 2122) that a width of 30 feet would be necessary for the outer arm. At all events, the cost of the 3,000 feet remaining to be constructed will be greater per linear foot than that heretofore estimated. An appropriation of $233,737.91, the balance of the original estimate of $800,000, is recommended for the fiscal year ending June 30, 1896.

A report of Lieut. C. H. McKinstry, Corps of Engineers, submitting his notes on the section most suitable for continuing the extension of the breakwater, is appended hereto.

APPROPRIATIONS.

Act of—		
March 3, 1881		$100,000.00
August 2, 1882		100,000.00
July 5, 1884		85,000.00
August 5, 1886	$60,000.00	
From which allotted to Milwaukee Harbor	4,737.91	
		55,262.09
August 11, 1888		70,000.00
September 19, 1890		80,000.00
July 13, 1892		75,000.00
Miscellaneous receipts credited to appropriations		1,000.00
Total		566,262.09

Money statement.

July 1, 1893, balance unexpended	$85,544.47
June 30, 1894, amount expended during fiscal year	81,626.34
July 1, 1894, balance unexpended	3,918.13
Amount (estimated) required for completion of existing project	233,737.91
Amount that can be profitably expended in fiscal year ending June 30, 1896	233,737.91

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF LIEUT. C. H. M'KINSTRY, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., June 4, 1894.

MAJOR: I have the honor to submit the following notes on the section most suitable for use in continuing the Milwaukee breakwater:

The damage inflicted on the breakwater by the storm of April 19, 1893, was so extensive as to require not only repairs but also material reenforcement of the entire outer arm, and even (Report of 1893, p. 2742) to suggest the advisability of adopting a new project for the 3,000 feet that remain to be constructed. Of the many types of breakwater construction that could be successfully used at Milwaukee all that require expensive plant are barred, since in all probability the appropriations will never be sufficient in amount to justify a great outlay for plant. This excludes, therefore, the upright wall types of concrete blocks, concrete in mass, or concrete in bags; the mixed type of stone or concrete superstructure on a rubble base; and such of the mound breakwaters as involve the use of very heavy blocks, natural or artificial. The Point Judith and Sandy Bay sections are typical of the mound breakwaters recently constructed or proposed for construction in the United States. The first (fig. 2) is suitable for moderate depths and moderate exposure. The second (fig. 1) is suitable for the greatest exposure and depths up to at least 50 feet. All that experience has taught at Delaware and at mound breakwaters abroad is embodied in this profile. But the maintenance of its steep slopes above water is dependent on the use of stones of the largest size—expensive to quarry and to place. In August last a circular letter was sent to various quarrymen in this neighborhood and at Sturgeon Bay asking prices, in the work, of blocks of stone weighing from 2 to 15 tons. Only two bids were received for the largest stones, 5 to 15 tons, viz, $3.25 and $5 per ton. The most favorable bid was $1.50 for blocks weighing 1 to 5 tons.

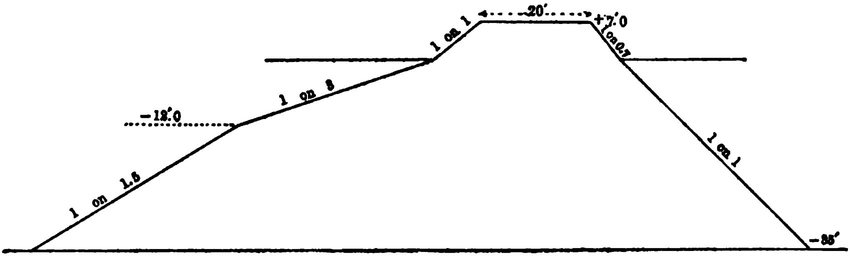

FIG. 1.—Sandy Bay Section, slightly modified to suit conditions at Milwaukee.

Taking small stone at $7 per cord and large stone at $15 per cord (i. e., $1.50 per ton) and allowing 30 per cent for voids, the Point Judith section (fig. 2) in 35 feet of water, the depth in which the remainder of the Milwaukee breakwater is to be constructed, would cost $178.64 per linear foot; allowing 20 per cent for voids, $214.37. Judging from the weight of a cubic yard of settled enrockment at Delaware (House Ex. Doc., Fifty-second Congress, first session), the former is the more accurate estimate.

Crib breakwaters.—But is it certain that a stable crib breakwater could be constructed at a first cost less than this, and in determining the dimensions, and therefore cost, of the crib of desired stability, much assistance is to be obtained from an inquiry into the injuries which the existing work has sustained.

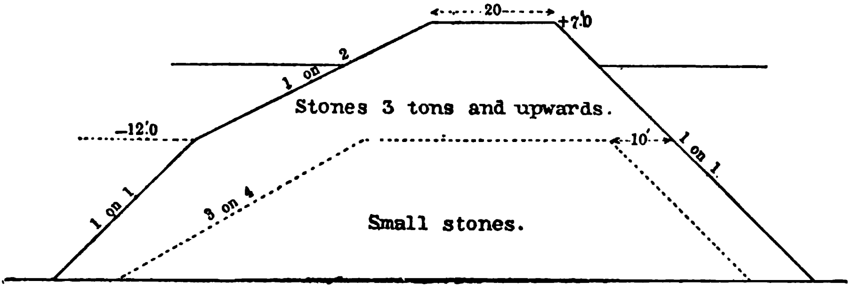

FIG. 2.—Point Judith Section.

Section, exposure and damage of "outer" arm.—The width originally contemplated for the outer arm of the breakwater was 30 feet (Report of 1881, p. 2123), but the "elbow" having been reached with cribs 24 feet wide without any of them being overturned, it was thought to have been demonstrated that a width of 24 feet was sufficient. The most severe storms undoubtedly come from the northeast, and it was thought that the exposure of the eastern arm (the line of which runs south 11° west) would be no greater than that of the northern arm (the line of which runs south 25° east). But considering the difference in the depth of water in front of the two arms, the shelter afforded during northerly gales to the northern arm by North Point, and the angle at which the storms strike, it is not surprising that the eastern or outer arm is found to be more severely tried by easterly and southeasterly seas than the northern arm by the severe northeast storms. Already in the eastern arm five 50-foot cribs and one 100-foot crib have been overthrown. It may be mentioned in this connection that all the other breakwaters on the lakes, except that at Marquette, are more than 24 feet wide (see table, p. 2558, Report of 1891), while the fetch of the sea and the depth of water at Milwaukee are as great as at most of the other breakwater harbors. The breakwater at Marquette (new work) is 24 feet wide and is banked up on the outside with stone to the height of 7 feet above the bottom of the cribs (compare with figs. 1, 2, and 3).

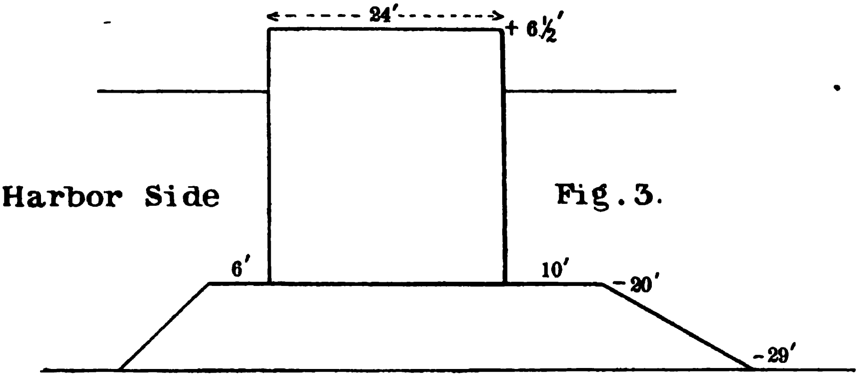
Fig. 3.

Cribs 47 and 48—[each 50 feet long, overturned April 19, 1893].

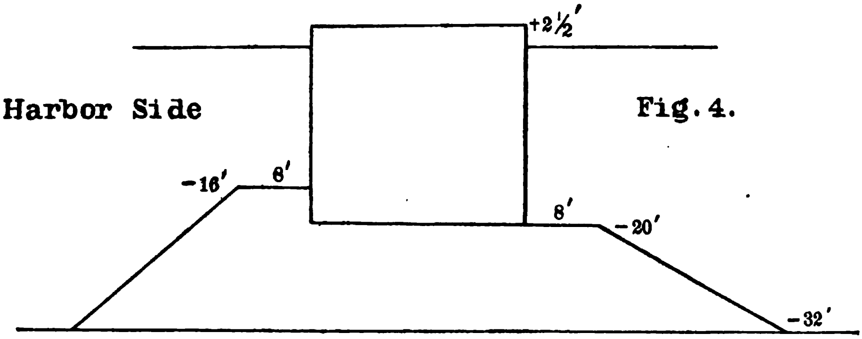
Fig. 4.

Crib 66—[100 feet long, overturned Jan. 1, 1891].

Of the six cribs that have been overturned, three (Nos, 54, 55, and 56) are supposed to have been pushed over by a rapidly moving ice floe (letter of Capt. W. L. Marshall, Corps of Engineers, to the Chief of Engineers, May 9, 1887); the other three were undoubtedly overturned by the force of the waves. The dimensions of these

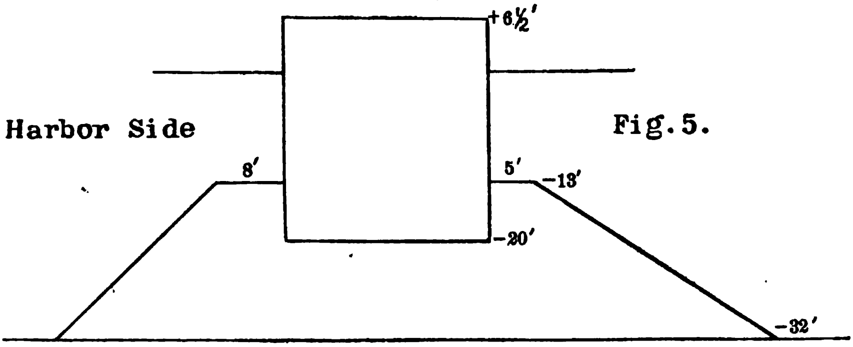
Fig. 5.

Outer arm, as reinforced in 1893.

last cribs and of the stone substructure on which they stood are shown on the sketches (figs. 3 and 4).

Fig. 5 shows the manner in which the stone substructure was reenforced in 1893, after the storm of April 19, and represents the present condition of the outer arm. (Even more stone than the project called for was put in, especially on the harbor side.)

Cause of the overthrow of these cribs.—The overthrow of these cribs (figs. 3 and 4) could be explained by supposing that they were fractured, or that the foundation yielded near the inner lower edge of the crib; but these suppositions are disproved by the results of the examination of the wrecked cribs (letter of Capt. W. L. Marshall, above quoted; also report of W. H. Hearding, assistant engineer, May 27, 1891). Nor does it seem likely that the cribs were moved bodily toward the harbor until they reached the crest of the inner slope, where, of course, their overthrow would have been unavoidable; for while many of the remaining cribs are at the top slightly tilted toward the harbor, their side walls at the bottom are on perfect line, except Crib 62 (end crib of northern part of outer arm), the south end of which has moved as near as can be judged about 15 inches to the westward.

The only remaining hypothesis is that the cribs simply turned about the lower inner edge. Maj. Davis (Report of 1891, p. 2557) states it is probable that this (the overthrow of the crib) was done gradually by rocking the crib and letting some of the stone out through the bottom grillage, and not by some one wave of very unusual intensity. It does not follow from this, however, that the loss of these cribs was entirely due to insufficient width. It should be remembered that two of the cribs overturned were 6½ feet high above water, while one was 2½ feet high. Now, it is plain that the low crib escapes a great part of the blow which is dealt to the high one. With each wave that reaches the work a great mass of water can be seen pouring across the low crib, while at the high one this mass is thrown into the air. Even supposing that the wave does not strike the superstructure a blow, it is plain that the deflection upward of this mass of water is not accomplished without a great pressure against the work, and this pressure is what the low crib escapes.

Indeed, when the blow which the waves strike against the lake face of the high crib is compared with that which they strike against the lake face of the low one, it is difficult to account for any of the high ones enduring a storm sufficiently severe to overthrow a low one. The explanation is, I think, that the cribs which have been overturned were decked with thin planks; that these planks, as in numerous other instances, were broken and washed away; that stone was washed out, and the harbor wall and inner longitudinal wall were thus left exposed to the blow of the mass of water which is thrown across the work (see fig. 7). As long as the decking remains intact the overturning effect of a mass of water rushing across the work or striking the top obliquely is inconsiderable; but when the harbor and middle walls are exposed to normal impact, the overturning effect must be immensely increased. And this result is due not only to the fact that additional points of attack are afforded to the waves, but also and especially to the fact that the blow inflicted against these inner walls is much more severe than that against the lake wall.

This was exemplified in the storm of April, 1893, when the lake wall of the outer arm, although almost unsupported, escaped with but little damage, while the harbor and interior longitudinal walls (1,500 feet in length) were demolished. And again, during the work of repairs conducted last fall, the lake and harbor walls along cribs Nos. 60, 61, and 62 had been carried up 4 or 5 courses above water, when a storm occurred (September 30) in which the entire harbor wall—200 feet in length—was carried away, while the seas passed over the lake wall, just opposite, without injuring it.

This deduction is also confirmed by the striking results obtained with the dynamometers on the breakwater last winter. In the storm of February 12, 1894, the dynamometers were on top of Crib No. 68 (a crib with superstructure), one on the harbor side and the other with its disc flush with the lake face. They were, therefore, about 6½ feet above water. The pressure registered by the first was more than 1,430 pounds per square foot (how much greater the pressure actually was it is impossible to say; 1,430 pounds was all the instrument could record), and by the second less than 200 pounds. The wind was from the northeast, velocity about 36 miles. In the storms of April 8–9, 1894, and May 18, 1894, both dynamometers were on top of Crib No. 70 (a crib without superstructure), about 2½ feet above water, therefore. In the first the dynamometer on the harbor side read 3,460 pounds per square foot (all it could read) and the other read less than 300 pounds; wind northeast to southeast, velocity about 39 miles. In the second storm the dynamometers read respectively 1,970 and 316 pounds; wind north to northeast, velocity about 40 miles.

The difference in the character and intensity of the blow inflicted against the inner and outer walls appears from the direction and velocity of the striking mass.

The following sketch (fig. 6) taken from Vernon-Harcourt's Harbors and Docks, and representing the action of the waves at Alderney, also represents, though in an exaggerated manner, the action of the waves at Milwaukee:

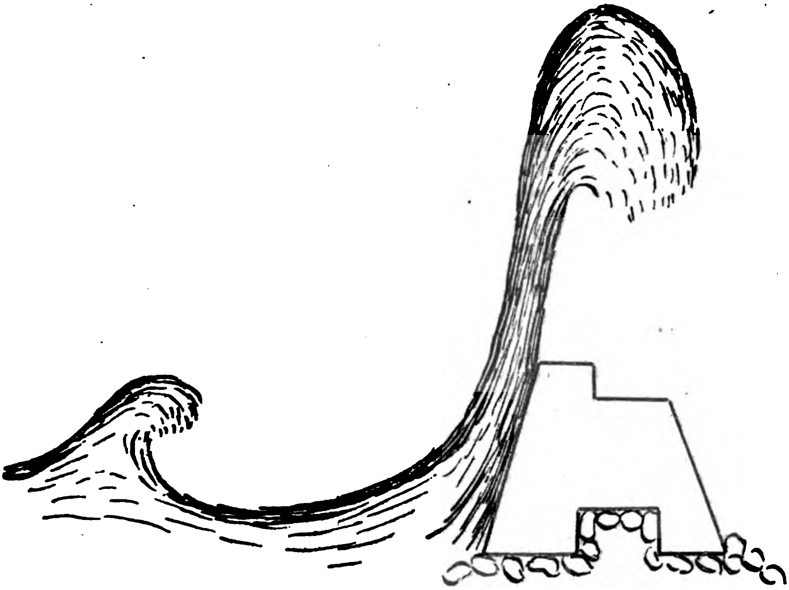

FIG. 6.—Wave striking Alderney Breakwater. [From Vernon Harcourt's "Harbors and Docks"].

The following (fig. 7) is a more exact representation:

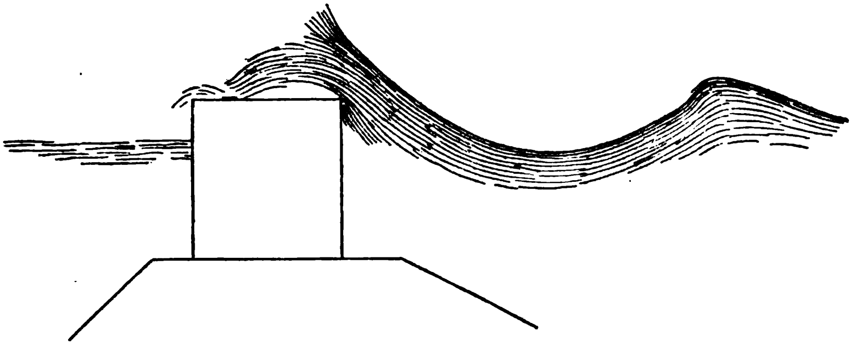

FIG. 7.—Wave striking Milwaukee Breakwater.

If so, it is at once apparent that the inner walls, when exposed, are struck normally by a rapidly moving mass of water, while the outer wall, if struck at all, is struck an upward glancing blow.

The conclusion can not be escaped that the exposure of the inner walls adds greatly to the force acting to overturn the crib.

Intensity and distribution of the forces acting to overturn the crib.—Technically the outer arm at the time Cribs 47, 48, and 66 (figs. 3, 4, and 5) were overturned was not an "upright wall" but a "mound with superstructure;" however, on account of the depth at which these cribs were founded and of the comparatively small size of the storm waves, it is probable that the shelving stone substructure had little or no effect on the force of the wave, and that the circumstances were such as would obtain were the cribs founded on the bottom of the lake. This probably is not true of the present section of the outer arm (fig. 5), for the bank of stone piled against the outer face and rising to within 12 feet of the water surface may act to trip the wave and to cause it to strike a severer blow. As Vernon-Harcourt says: "A shelving rubble base (as in the mixed system) tends to break the wave as it approaches the superstructure, which, when situated in a certain depth of water, is liable to receive the more concentrated shock of the breaking wave."

It was Mr. Scott Russell's opinion that "the reflection [of a roller by an upright wall] really converts the whole effect of the roller on itself into a simple pressure of water When such a wave is reflected on a perpendicular wall, it merely produces a hydrostatic pressure equal to that due to a little more than double its own height. A roller 20 feet in height would produce a pressure of about 1 ton per foot and would be reflected by a wall of moderate dimensions." This, however, is not the present view. Mr. Thomas Stevenson says:

"The principle asserted in favor of the vertical wall is that oceanic waves in deep water are purely oscillatory and exert no impact against vertical barriers, which therefore have only to encounter the hydrostatic pressure due to the height of the reflected billows, which are reflected without breaking. But we have very good reason for believing that any form of barrier, in whatever depth of water it may be placed, *must occasionally be subject to heavy impact*."

And Mr. Vernon-Harcourt says:

"It can not be admitted that waves coming against an upright wall are merely oscillatory waves and inflict no blow upon the structure."

Probably the forces acting are, first, the hydrostatic pressure due to the mere excess of head against the sea face of the work, and, second, the pressure exerted against the upper part of the face of the work by the breaking or partially broken wave. In the case of the Milwaukee breakwater observation shows that sometimes into the hollow caused by a falling wave the succeeding wave rushes with great velocity, striking a sudden blow or slap, from about the level of the trough of the waves to the top of the superstructure, with the result that a mass of water is thrown straight up into the air and falls or is blown by the wind across the work, chiefly a spray; while at other times this hollow is quickly filled just before the blow is delivered, with the result that the wave is deflected upward and falls in a mass obliquely on the decking (fig. 7). How the pressures acting against the upper part of the face of the work in these two cases compare with each other, or with the mere hydrostatic pressure due to the excess of head on the lake side, it is impossible to say. The dynamometer observations, however, enable us to set approximate values. It is not pretended that the overturning impulses exerted at different parts of the work are proportional to the dynamometer indications. The dynamometers are rated by dead weights, and Stevenson held that a wave acting against the instrument and registering, say 1,000 pounds per square foot, was in every way represented by a dead weight or pressure of 1,000 pounds per square foot. Hagen, on the contrary, was of the opinion that a breaking wave struck a blow like a solid body, and, furthermore, that the inertia of the moving parts of the dynamometer might carry the plate beyond the proper point. Granting, however, that the true law of intensity and distribution of forces is unknown, it is thought that by means of the dynamometer observations an idea sufficiently near the truth can be obtained to enable the stability of cribs of various forms and dimensions to be tested.

Now, the greatest pressure which has been recorded as acting against the lake face is 450 pounds per square foot (about 1 foot above normal water surface, storm of April 19, 1893). In the storms of last winter the greatest pressure on the lake face was 316 pounds. The maximum height of wave being about 13 * feet, let us assume that the pressure due to the breaking wave—540 pounds per square foot—is distributed over the face of the work from 6½ feet below normal water surface to the top of the superstructure, 6½ feet above water surface. The ordinates of the line *d e*, fig. 8, represent this pressure. (As a matter of fact the pressure due to the breaking wave is probably greatest at or just above water surface, and diminishes rapidly above and below.) The excess of head against the lake face causes a pressure which is represented by the broken line *a b c*. The total pressure exerted by the wave is then represented by the ordinates of the line *d g h k c*, obtained by combining *a b c* and *d e*. This line should, of course, be a curve, say like the dotted line; but the resultant of the pressures represented by *d g h k c*, 16,459 pounds, acting 4.77 feet below water surface, is thought to be a fairly accurate estimate of the force acting to overturn the crib. Now the pressure which acting 4.77 feet below water surface will just overturn the crib is 21,790, or the factor of safety of the crib against overturning is about 1.3. But considering the decking to have been washed away and the inner walls to be exposed, and allowing a pressure of 1,200 pounds per square foot (a low estimate—see dynamometer observations above) to act against 6¼ feet in height of harbor wall and 3¼ feet of middle wall, the total pressure acting becomes 28,159 pounds, with its point of application 1.21 feet below water surface, while the pressure which acting at this point will just overturn the crib is 17,662 pounds, or the overthrow of the crib is inevitable, *unless the inner walls are beaten down*. In the storm of April, 1893, then, in which besides 2 cribs being overturned, 1,500 linear feet of superstructure, especially inner walls, were demolished, it was probably only the destruction of these inner walls of the superstructure that prevented other cribs from being overturned. It is curious to note that the estimated pressure acting against the *inner walls alone* is 81 per cent of that required to overturn the crib; in other words, if the estimated pressure per square foot (1,200 pounds) or the estimated area over which it acts has been taken too small, the overthrow of the crib can be explained by the pressure against the inner walls alone. It must be said that there is some doubt whether the wave acts against the inner and outer walls simultaneously.

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* Maj. Davis assumed 12 feet as the maximum wave height (Report of 1891, p. 2557).

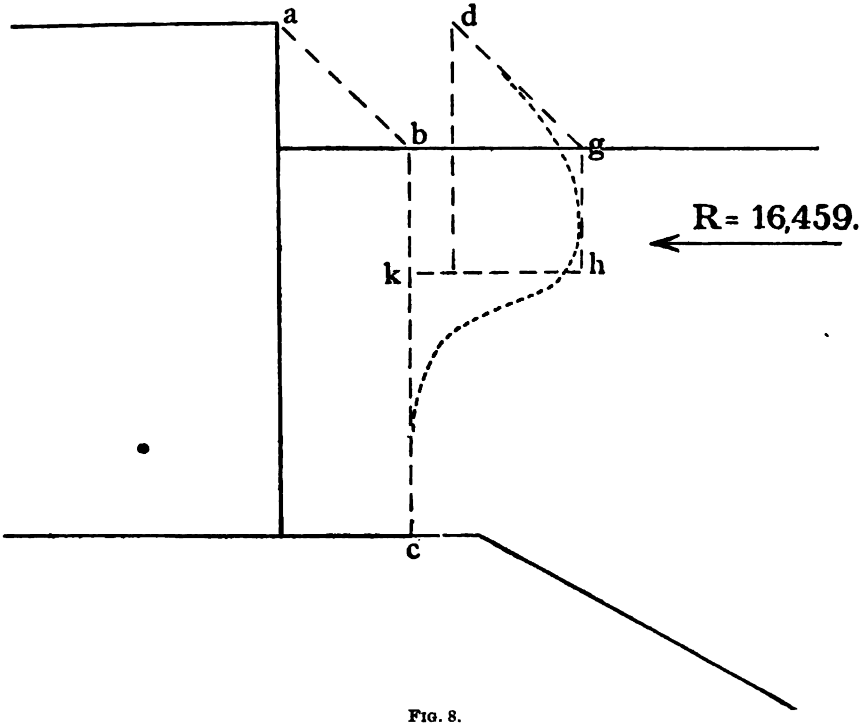

FIG. 8.

Applying figures to the case of the crib without superstructure (fig. 4) we have 14,027 pounds as the pressure acting against one linear foot of the outer face, the point of application being 6.52 feet below water surface. The pressure which acting at this point will overturn the crib is 20,903 pounds. But considering the inner walls to be exposed and a pressure of 1,600 pounds per square foot (a very low estimate, considering that the dynamometer had registered more than 3,000 pounds) to act against 5[*] feet in height of harbor wall and 2½ feet in height of middle wall, the total pressure becomes 26,027 pounds, with its point of application 3.32 feet below water. The pressure which acting at this point will just overturn the crib is 16,893 pounds. The pressure acting against the inner walls alone is here 87 per cent of the pressure required to overturn the crib.

It appears therefore from these figures that both in the case of the crib with superstructure and of the crib without superstructure, the crib will be overthrown if the inner walls are exposed; while if the decking remains intact the maximum safe pressure which the high crib will support without overturning exceeds the probable actual pressure by about 30 per cent, the excess in the case of the low crib being about 50 per cent. Moreover when the inner walls are exposed, the pressure acting against these walls alone is *probably* sufficient to overturn either the high or the low crib.

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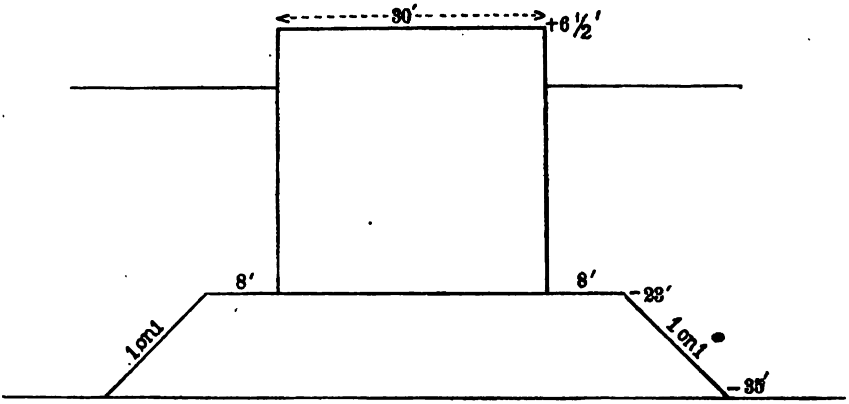
[*] The pressure against harbor wall is taken to act to the depth of 2½ feet below water surface.

Probable stability of present reenforced section.—These conclusions do not, however, apply to the present reenforced section of the outer arm (fig. 5). It is plain that the factor of safety of the cribs has been greatly increased over 1.3 by the stone piled up against both lake and harbor faces. And the fact that the 6 by 8 inch decking with which the outer arm was covered last fall has already passed through three severe storms without the slightest injury is sufficient proof that it is now strong enough. It is probable, therefore, that no more of the cribs of the outer arm will be overthrown.

Stability of crib 30 feet wide.—This reenforced section is, however, not well suited for continuing the work, and in the greater depth of water in which the remainder of the breakwater is to be built the strength represented by the old section plus the reenforcement can be secured at less cost.

The figures above used might be applied in succession to cribs 26, 28, and 30 feet wide until one was found of the desired stability. It suffices perhaps to apply them at once to the 30-foot crib.

Fig. 9 shows the section that could be used in 35 feet of water.



Steeper slopes for the stone substructure are admissible than in the case of the 24-foot crib founded 20 feet below water, since the foundation does not rise to the limit of wave disturbance.*

As before, the total pressure acting against the lake face is 16,459 pounds, with its point of application 4.77 feet below water. The pressure which acting at this point will just overturn the crib is 33,075 pounds, or the factor of safety of the crib is more than 2.0. But even the 30-foot crib is not safe if the inner walls are exposed, for the estimated pressure acting is 28,159 pounds, while the pressure which acting at the same point (viz, 1.21 feet below water) will just overturn the crib is 27,159 pounds.

The 30-foot crib *without* superstructure would be safe in any case.

Cost of proposed section compared with present reenforced section.—It was stated above that strength equal to that of the present section could be obtained at less cost. The cost of the present section is as follows:

Superstructure per linear foot (actual cost last year)	$26.51
Crib (actual)	61.25
Stone substructure and reenforcement (estimated)	68.39
Total	156.15

The estimated cost of the proposed section, considering all the timber to be pine, is as follows:

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*The "limit of wave disturbance" for half-ton stones, if one winter's experience is sufficient test, is here about 13 feet below water surface. For stones of the size ordinarily used for the substructure, weighing, say 250 pounds, it is more than 20 feet below water surface. At 23 feet below, stones of this size could probably be used with perfect safety.

Superstructure (5 courses)	$33.14
Crib (24½ courses)	86.77
Stone foundation	38.01
Total	157.92

But hemlock has been used with perfect success below water at Chicago and elsewhere; and the saving effected by using it in eighteen intermediate courses of the proposed crib (the ties, however, to be of pine) would amount to at least $5 per linear foot, or the estimated cost of the proposed section, using hemlock as described, would be $152.92.

An application of Maj. M. B. Adams' formula for determining the most economical height of stone foundation (Report of 1893, p. 3202; also 1887, p. 2407) indicates that with the prices obtaining here the stone foundation in 35 feet of water ought not to rise more than 7 feet above the bottom; or that the crib, including superstructure, ought to be 35½ feet high. The decrease in the cost would result from thus reducing the height of foundation 12 feet to 7 feet, and increasing the crib from 29½ to 35½ courses high, would be very little, while the loss of stability in the crib would be considerable, for the factor of safety would be reduced from 2.0 to 1.5.

It would seem that the crib 30 feet wide and about 29.5 feet high (that is founded about 23 feet below water surface) is the most suitable.

But as between this section, costing $152 per foot, and the Point Judith section, costing at this place $178 per foot, the choice is not so easily made. The difference, $26 per foot, would probably pay for rebuilding the timber superstructure once, or would insure the work for from twenty-four to twenty-six years. It would also go a long way toward constructing a permanent superstructure on the crib substructure. Indeed, the permanent superstructure could probably be constructed at once with $26 plus the cost of a timber superstructure. The cost of maintaining the rubble mound is something that can not be calculated in advance.

Very respectfully, your obedient servant,

C. H. McKinstry,
First Lieut. of Engineers.

Maj. James F. Gregory,
Corps of Engineers.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1983.

Name of harbor, Harbor of Refuge, Milwaukee Bay, Wisconsin; collection district, Milwaukee, Wis.; amount of revenue collected at nearest port of entry, $475,749.67.

J J 18.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the Milwaukee River, which is the interior harbor of Milwaukee.

Project.—The original project adopted in 1852 provided for the formation of a channel 260 feet wide and 12 feet deep by dredging across the point which overlapped the mouth of the Milwaukee River, at the distance of 3,000 feet to the northward of its original outlet, and by the construction of parallel piers of crib work each 1,120 feet in length, for the protection of the sides of the channel thus formed. In 1868, an extension of the piers became necessary for the requirements of commerce, and under a continuation of the original project both the north and south piers were extended 600 feet into the lake to 18 feet depth of water.

Present works.—The entire length of the channel between the piers is 1,740 feet; its width at the outer end has been increased through the outward settling of cribs to 284 feet.

The width of each of the 1,120-foot sections of piers first built is 20 feet. The pier extensions of 600 feet in length are 26 feet wide, excepting the pier heads, which are each 30 feet wide and 50 feet long, protected by a bulkhead of piles and oak timbers.

The superstructure of the inner section of the north pier for 1,052.6 feet of its length by 20 feet in width is of quarry-faced dry stone masonry, the side walls being 4 feet thick. Between these walls for a length of 663 feet the filling is of stone, packed with gravel and covered with large paving stones of 9 inches in thickness. The filling between walls for the remaining 389.6 feet is of packed stone, with a top layer of concrete pavement of 9 inches in thickness. Piles for the protection of the piers have been driven along the channel faces. The superstructure over the pier extensions of the 600 feet was built in 1871 and 1872. In 1887 the superstructure of the 600-foot extension of the north pier was cut down and rebuilt. In 1889 the superstructure of 400 feet of the outer section of the south pier was cut down and rebuilt. In 1893 200 linear feet of the superstructure of the outer portion of the south pier—width, 26 feet—were cut down and rebuilt; repairs were made to 150 feet of superstructure at the west end of the north pier and to 100 feet at the west end of the south pier; and the pile protection (1,053 linear feet) of the stone superstructure was renewed.

Depth of water.—A plat of soundings taken on March 16, 1894, shows that between the piers there is a channel 100 feet wide and slightly more than 16 feet deep.

Operations during the fiscal year.—None.

Remarks and recommendations.—In the report of June 30, 1889, the needs of this harbor were stated in detail. The deterioration of the piers from wear and climate has been steadily progressing since that time. In 1879 it was estimated that an average yearly expenditure of $10,000 would be required for the maintenance of this harbor. Since that time the average yearly expenditure has been but $4,218.30, or a total of the sums appropriated in thirteen years of $54,837.91.

The superstructure of the south pier for a length of 1,000 feet is in a very dilapidated condition, and should be renewed as soon as practicable. An estimate of the cost of doing this work, which is 20 feet wide, is $11 per running foot, or $11,000 for cutting down and rebuilding this section of the pier. The channel is maintained with less dredging than is done at many harbors on Lake Michigan, but in order to provide a sufficient depth for many deep-draft vessels which enter this harbor, or a full depth of 19 feet, it will be necessary to excavate about 40,000 cubic yards of material. For repairs of piers and dredging an appropriation of $20,000 is recommended.

APPROPRIATIONS.

Expended on former mouth of Milwaukee River.

Act of—	
July 4, 1836	$400.00
March 3, 1843	30,000.00
June 11, 1844	20,000.00

Straight cut.

Act of—	
August 30, 1852	$15,000.00
March 3, 1853	163.94
June 23, 1866	48,283.51
April 10, 1869 (allotted)	35,640.00
July 11, 1870	40,000.00
March 3, 1871	38,000.00
March 3, 1873	10,000.00
June 23, 1874	10,000.00

Act of—	
March 3, 1875	$25, 000. 00
August 14, 1876	26, 000. 00
June 18, 1878	15, 000. 00
March 3, 1879	7, 500. 00
June 14, 1880	10, 000. 00
March 3, 1881	8, 000. 00
August 2, 1882	10, 000 00
August 5, 1886 (from appropriation for harbor of refuge)	4, 737. 91
August 11, 1888	10, 000. 00
March 17, 1890 (special act)	6, 100. 00
September 19, 1890	6, 000. 00
July 13, 1892	14, 000. 00
Total expended at old river mouth and straight cut	389, 825. 36
Expended at former mouth of Milwaukee River	50, 400. 00
Total expended at straight cut (present harbor)	339, 425. 36

Money statement.

July 1, 1893, balance unexpended	$7, 529. 27
June 30, 1894, amount expended during fiscal year	6, 870. 55
July 1, 1894, balance unexpended	658. 72
Amount (estimated) required for completion of existing project	20, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	20, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

Name of harbor, Milwaukee, Wis.; collection district, Milwaukee, Wis.; amount of revenue collected during the year, $475,749.67.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	3, 696	3, 283, 561	3, 765	3, 310, 767
Sail	1, 411	280, 310	1, 453	265, 644
Total	5, 107	3, 563, 871	5, 218	3, 576, 411

The following receipts and shipments are taken from the annual report of the secretary of the Chamber of Commerce, and are the receipts and shipments by all means of transportation:

Receipts and shipments.

Articles.	Quantity.	Articles.	Quantity.
RECEIPTS.	*Tons.*	RECEIPTS—continued.	
Barrel stock	13, 185	Grain:	*Tons.*
Beans	187	Wheat	384, 189
Brick	1, 516	Corn	40, 767
Butter	1, 799	Oats	129, 560
Cement	59, 621	Barley	282, 000
Cheese	4, 826	Rye	34, 286
Coal	1, 249, 732	Hay	14, 044
Cranberries	110	Hides	10, 419
Eggs	2, 503	Hops	1, 399
Flaxseed	13, 839	Iron ore	54, 900
Flour	201. 365	Iron, pig	22, 455

Receipts and shipments—Continued.

Articles.	Quantity.	Articles.	Quantity.
RECEIPTS—continued.		SHIPMENTS—continued.	
	Tons.		*Tons.*
Live stock:		Cranberries	1
Hogs	43,446	Flaxseed	3,956
Cattle	20,348	Flour	329,087
Sheep	2,173	Grain:	
Calves	1,142	Wheat	104,731
Lime	29,524	Corn	12,542
Lumber	458,004	Oats	91,921
Lath	1,123	Barley	146,138
Malt	19,934	Rye	25,310
Paper	26,106	Hides	674
Peas	6,587	Iron, pig	63,548
Potatoes	10,240	Live stock:	
Posts	7,554	Hogs	4,935
Seeds	2,302	Cattle	6,042
Shingles	3,105	Sheep	899
Salt	89,653	Calves	99
Stone	61,543	Lumber	79,128
Wooden ware	8,985	Lath	2,744
Wood	6,377	Malt	57,158
Wool	1,123	Peas	1,908
		Potatoes	1,803
Total	3,321,971	Shingles	1,213
		Salt	8,050
SHIPMENTS.		Wool	956
Butter	213		
Coal	532,993	Total	1,485,089

J J 19.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into Root River, at the mouth of which the city and harbor of Racine are situated.

Project.—The original project for the improvement of this harbor was made and adopted in 1842–'43. Its intention was to provide and maintain a channel 12 feet deep by dredging between protection piers constructed of crib work placed parallel to each other and 160 feet apart, the distance from the shore line to 12 feet of water in Lake Michigan being about 800 feet.

In 1866 the project was modified with a view of providing a channel of 15 feet in depth.

Under this modification the north pier was extended 630 feet and the south pier about 500 feet. A further modification was made in 1889, which called for an extension of the north pier 300 feet and of the south pier 500 feet, and an increase in the depth of water in the channel to 16 feet, at which time the north pier extended 380 feet farther into the lake than the south pier.

Present works.—The north pier is about 1,610 feet long. Its western section of 200 feet in length is 12 feet wide; its middle section, 960 feet in length, is 20 feet wide; 300 linear feet of its outer or eastern section is 30 feet wide, and the remainder (150 linear feet) is 24 feet wide. The south pier is 1,370 feet long; its inner or western section of 530 feet in length is 16 feet wide, and its outer or eastern section is 840 feet long and 20 feet wide. The north or weather pier now extends 230 feet farther into the lake than the south pier. To complete the pier extension contemplated by the modified project of 1889 there remain to be constructed 150 feet of north pier and 200 feet of south pier.

Depth of water.—The natural depth of water on the bar in front of the mouth of the river before artificial improvement was made was variable. The effect of a northeast storm would be to deposit sand to such an extent as to completely obstruct the entrance until an accumulated head of water in the river became sufficient to remove the barrier, and upon a change of wind sometimes a narrow channel of 5 or 6 feet in depth would be scoured out.

The work done under the project previous to 1860 provided a channel of from 9 to 10 feet in depth. The extension of the piers, with the periodical dredging which has been done since 1866, has generally maintained a channel of from 13 to 15 feet in depth, but the maintenance of a 15-foot channel is dependent upon a frequent use of the dredge.

A plot of soundings taken in April, 1894, showed a narrow channel 13 feet deep. Eight thousand nine hundred and sixty-four cubic yards of material were dredged in May, 1894, and resulted in the formation of a channel 60 feet wide and 14½ feet deep.

Operations during the fiscal year.—Under contract dated September 29, 1892, with D. A. McLeod, of Manistee, Mich., the north pier was extended 150 feet and the south pier 100 feet, and the old outer end of the north pier was repaired. Also, as above stated, 8,964 cubic yards of material were dredged from the channel between the piers.

The north pier extension consists of 3 cribs, each 50 feet long and 24 feet wide, founded on riprap and on piles. The piles are cut off 16½ feet below datum, and the cribs are protected on both sides by riprap carried up to 12 feet below datum. Average depth of water about 17 feet. These cribs were covered with superstructure carried up to the height of 5 feet above datum. Cost of extension per linear foot, $88.30.

The south pier extension consists of 2 cribs, each 50 feet long and 20 feet wide. The foundation piles are cut off 12½ feet below datum, and the cribs are protected by riprap carried up on the channel side to 10½ feet below datum and on the lake side to 8½ feet below datum. Average depth of water about 14 feet. Cost of this extension, including superstructure, per linear foot, $52.80.

Remarks and recommendations.—The superstructure of the western section of the north pier, 200 feet in length by 12 feet in width, and 635 feet of its middle section of 20 feet in width, is in a dilapidated condition, as is also 310 feet in length of the superstructure of the west end of the south pier. Twenty-three thousand dollars, it is estimated, will be required for this work of reconstruction.

South of the axis of the channel, to the east of the end of the south pier and extending lakewards 300 feet beyond the end of the north pier, an extensive bar has formed and is constantly increasing in size. There is urgent need, therefore, of prolonging the piers, at least to the extent contemplated by the modified project of 1889. These extensions (north pier 150 feet, south pier 200 feet) are estimated to cost $30,000. To dredge the channel to the depth contemplated by the project and to remove the bar between the pier heads will require the removal of about 15,000 cubic yards of material at an estimated cost of $3,500. The aggregate amount needed for this work at this harbor is, then, $56,500.

Besides the amount (estimated) required for completion of existing project—$39,500—the appropriation of an additional $17,000 for repairs of piers and maintenance of channel is recommended for the fiscal year ending June 30, 1896.

APPROPRIATIONS.

Act of—	
June 15, 1844	$12,500
August 30, 1852	10,000
June 28, 1864	3,600
June 23, 1866	23,910
March 2, 1867	45,000
April 10, 1869 (allotted)	22,275
July 11, 1870	10,000
March 3, 1871	10,000
March 3, 1873	20,000
June 23, 1874	10,000
March 3, 1875	10,000
August 14, 1876	8,000
June 18, 1878	$10,000
March 3, 1879	6,000
June 14, 1880	6,000
March 3, 1881	6,000
August 2, 1882	7,000
July 5, 1884	7,000
August 5, 1886	10,000
August 11, 1888	10,000
September 19, 1890	17,500
July 13, 1892	25,000
Total	289,785

Money statement.

July 1, 1893, balance unexpended	$23,815.79
June 30, 1894, amount expended during fiscal year	23,751.34
July 1, 1894, balance unexpended	64.45
Amount (estimated) required for completion of existing project	56,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	56,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by the mayor of Racine, Wis.]

Name of harbor, Racine, Wis.; collection district, Milwaukee, Wis.; nearest port of entry, Milwaukee, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	599	618,947	602	623,222
Sail	327	54,414	327	53,517
Total	926	673,361	929	676,739

Principal articles of export and import.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Quantities.	Articles.	Quantities.
EXPORTS.	*Tons.*	EXPORTS—continued.	*Tons.*
Agricultural implements	29,434	Posts, fence	909
Apples	11	Potatoes	283
Beer	5,000	Provisions	290
Brick	21,496	Sash, doors, and blinds	1,058
Fish	26	Shingles	201
Flour	446	Stone	3,325
Lath	688	Wagons and carriages	7,898
Leather	518	Wood	1,575
Lime and cement	2,018	Wool	94
Lumber	16,500	Shoes	654
Malt	74		
Oats	295	Total	94,373
Oil	1,535		
Pork and beef	45	Total approximate value	$7,909,682

Principal articles of export and import—Continued.

BY ALL WAYS OF TRANSPORTATION—Continued.

Articles.	Quantities.	Articles.	Quantities.
IMPORTS.	*Tons.*	IMPORTS—continued.	*Tons.*
Agricultural implements	463	Oats	1,312
Apples	225	Oil	1,800
Bark, tan	1,600	Poles, telegraph	20
Barley	2,984	Posts, fence	1,634
Beer	4,900	Potatoes	255
Brick	646	Provisions	423
Butter	157	Rye	364
Chairs	165	Salt	900
Cheese	82	Sheep	272
Corn	706	Shingles	504
Eggs	195	Wheat	6,698
Fish	138	Wood	43,862
Flour	2,687	Wooden ware	183
Furniture	506	Wool	77
Hides	769	Gamboge	287
Hogs	500	Print paper	294
Iron and steel	2,2106	Tobacco	53
Lath	802	Sheepskins	155
Leather	240		
Lime and cement	1,710	Total	182,475
Lumber	81,000		
Marble	40	Total approximate value	$5,097,997.32
Merchandise, general	894		

J J 20.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

Object.—To secure a navigable channel from Lake Michigan into the extensive basin at the mouth of Pike Creek, upon which the city and harbor of Kenosha are situated.

Project.—The original project for the improvement of this harbor, adopted in 1852, was to secure a channel 12 feet deep from 12 feet of water in LakeMichigan to the interior basin or bayou by the construction of piers placed parallel to each other and 150 feet apart and by dredging between them. In 1866 a modification of the original project was made in order to provide a navigable channel 15 feet in depth.

A further modification or extension of the project was made in 1889 which provided for the extension of the north pier 300 feet and of the south pier 600 feet.

Present works.—The north pier is 1,700 feet long. Its inner or western section, which was built either by private parties or the city of Kenosha, is of pile work, 365 feet in length, and is 12 feet wide. The adjoining section to the eastward, built under the original project of 1852, is of crib work, 610 feet long and 18 feet wide. The extension of this pier since 1866 is 725 feet long, 250 feet of which is 30 feet wide. The south pier is 1,000 feet long and 20 feet wide, commencing at the shore line and extending into the lake. The north pier extends 320 feet farther into the lake than the south pier. To complete the pier extension contemplated by the modified project of 1889 there remain to be constructed 200 linear feet of north pier and 400 linear feet of south pier.

Depth of water.—The natural depth of water at the mouth of Pike Creek before it was improved changed with each recurring easterly storm; not more than 2 or 3 feet could be depended upon at the entrance. The work first done under the project furnished a channel of from 9 to 10 feet in depth between the piers.

The extensions of the piers since 1866, together with periodical dredging, have generally provided a channel about 12 feet in depth, but in order to maintain a greater depth of water frequent dredging has been necessary.

A plat of soundings taken April 10, 1893, showed that a bank had re-formed at the extremities of the piers, and also alongside the mid-section of the south pier, which by estimate would require the removal of 5,000 cubic yards of material. An agreement was made with Mr. S. O. Dixon to remove these obstructions at the rate of 25 cents per cubic yard. Under this agreement 5,048 cubic yards were removed, and resulted in a channel of navigable width 14 feet deep. This work was finished July 13, 1893.

A plat of soundings taken in April, 1894, shows pronounced shoaling, especially between the pier heads. Thirteen feet is all that the channel now carries. The 13-foot contour, starting from the end of the south pier, approaches within 90 feet of the north pier, and runs out irregularly in prolongation of the south pier to the distance of about 600 feet. Under such circumstances, it is only by a constant use of the dredge that a channel more than 12½ feet deep can be maintained. The need of extending the piers is obvious.

Operations during the fiscal year.—As above stated, the remainder of the dredging to be done under agreement entered into with S. O. Dixon on June 1, 1893, was finished July 13, 1893, the quantity of material dredged in July, 1893, being 2,354 cubic yards.

Under contract dated September 21, 1892, with Knapp & Gillen, of Racine, Wis., the north pier was extended 100 feet and the south pier 50 feet. The north pier extension consists of 2 cribs, each 50 feet long by 24 feet wide, founded on riprap and on piles. These piles are cut off 16½ feet below datum, and the cribs are protected by riprap carried up to 12 feet below datum. Average depth of water about 17 feet. Cost per linear foot of this extension, including superstructure carried up to 5 feet above datum, $94.78.

The south-pier extension consists of one crib 50 feet long by 20 feet wide; the foundation piles are cut off 12½ feet below datum, and the riprap protection is carried up on the channel side to 10½ feet below datum, and on the lake side to 8½ feet. Average depth of water, about 13 feet. Cost per linear foot, including superstructure, $65.64.

Remarks and recommendations.—South of the prolongation of the axis of the channel, and to the east of the end of the south pier—that is, under the lee of the north pier—an extensive bar has formed, carrying less than 12 feet of water. Only the constant use of the dredge, therefore, can keep open a channel 12½ feet deep, and the need of extending the piers, especially the south pier, is obvious. To prolong the piers to the lengths contemplated by the modified project of 1889, $49,500 is estimated to be necessary.

The superstructure of 800 feet of that portion of the north pier which was built in 1874–'75 is in very bad condition and should be renewed. For the preservation of the piers and for deepening and maintaining the channel, a further appropriation of $20,000 is recommended for the fiscal year ending June 30, 1896.

APPROPRIATIONS.

Act of—	
March 15, 1844	$12, 500. 00
March 3, 1845	15, 000. 00
August 13, 1852	10, 000. 00
June 23, 1866	75, 461. 41
April 10, 1869 (allotted)	5, 346. 00
July 11, 1870	10, 000. 00
March 3, 1871	10, 000. 00
June 10, 1872	10, 000. 00
June 23, 1874	10, 000. 00
March 3, 1875	15, 000. 00
August 14, 1876	8, 000. 00
June 18, 1878	8, 000. 00
March 3, 1879	$5, 000. 00
June 14, 1880	5, 000. 00
March 3, 1881	5, 000. 00
August 2, 1882	6, 000. 00
July 5, 1884	5, 000. 00
August 5, 1886	5, 000. 00
August 11, 1888	7, 500. 00
September 19, 1890	17, 500. 00
July 13, 1892	15, 000. 00
Total	260, 307. 41

Money statement.

July 1, 1893, balance unexpended	$15, 848. 44
June 30, 1894, amount expended during fiscal year	14, 814. 44
July 1, 1894, balance unexpended	1, 034. 00
Amount (estimated) required for completion of existing project	69, 500. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	69, 500. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by Dr. Wm. Farr, mayor of Kenosha.]

Name of harbor, Kenosha, Wis. Collection district, Milwaukee, Wis. Nearest port of entry, Milwaukee. Nearest light-house, Kenosha, Wis.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	41	6, 988	41	6, 988
Sail	145	14, 500	150	15, 320
Total	186	21, 488	191	22, 308

Principal articles of export and import.

BY WAY OF THE HARBOR ONLY.

Articles.	Quantity.
EXPORTS.	Tons.
Merchandise, general	1, 000
Sand	30, 000
Total	31, 000
Total approximate value	$50, 000
IMPORTS.	
Apples	60
Bark, tan	14, 300
Coal and coke	12, 000
IMPORTS—continued.	Tons.
Fruit	25
Lath	385
Lumber	12, 840
Posts, fence	114
Potatoes	120
Shingles	450
Stone	1, 750
Wood	3. 750
Total	45, 794
Total approximate value	$750, 000

J J 21.

IMPROVEMENT OF WAUKEGAN HARBOR, ILLINOIS.

Object.—To provide a shelter for the protection of vessels engaged in the commerce of the city of Waukegan.

Project.—In 1852 an appropriation of $15,000 was made for the "improvement of the harbor and breakwater at Waukegan, Ill." The plan adopted was a breakwater parallel to the shore in 20 feet of water. One crib, 30 by 25 feet, was placed in position, but was carried away by a storm, and the work then abandoned. In 1872 an examination and report were made, as called for by the river and harbor act of that year. This plan contemplated a breakwater in 24 feet of water. No action was taken on this report.

The character of the improvement of this harbor is somewhat different from that of other points on the Great Lakes. Most of the improvements have consisted in deepening the mouths of streams emptying into the lake, but at Waukegan there is only a creek emptying into the lake, and it is of no importance for harbor purposes.

The present project was adopted in 1880, its intention being to construct a basin of sufficient capacity to meet the requirements of the local trade by inclosing a portion of Lake Michigan within piers constructed of pile work, and an entrance channel between piers from a depth of 12 feet of water in Lake Michigan to the basin; the channel and basin to be excavated by dredging to the depth of 12 feet.

Present works.—The length of the north pier is 1,868 feet; length of the south pier is 1,287 feet. The north pier, which incloses the basin, is composed of five sections, the first of which runs easterly from inside the shore line as it existed in 1879 for a distance of 345 feet into the lake. This section is composed of a single row of 12 by 12 inch squared pine piles, reenforced at the angle or outer end for a length of 80 feet with oak piles, driven at a distance of 12 feet from the front row, the interior space being filled with stone ballast.

The next section, of pile work 16 feet wide, runs in a southerly direction for a distance of 380.8 feet to the channel angle.

The next section, of 16 feet in width, which runs in a southeasterly direction for a distance of 533.8 feet from the channel angle, is composed of two rows of closely driven white oak piles, divided into sections by cross rows driven at distances of about 32 feet apart, double-sheeted with 3-inch plank, and filled with stone ballast to a height of 2 feet above datum.

The fourth section, of 16 feet in width and 392 feet in length, is constructed in the same manner as the preceding section.

The fifth section, constructed in 1893, is 216 feet long and 20½ feet wide, and is similar in construction to the third and fourth sections. Like the fourth section, it is parallel to the line of the south pier, the distance between the piers being 236 feet.

The south pier is built upon a prolongation of the line of the south side of Madison street, in the city of Waukegan. The inshore section of this pier, 140.3 feet, is composed of a single row of square pine piles of dimensions 12 by 12 inches by 18 feet, with the exception of the outer 24 piles, which are 22 feet in length and 12 inches square.

The next outer section, of 100 feet in length, is constructed of round white oak piles, each 30 feet in length, on alignment at distances of 3 feet from center to center, and sheeted with two rows of planks of dimensions 3 by 12 inches by 22 feet, driven close and breaking joints, and spiked to the wales which inclose and secure the round piles.

The next section to the eastward, of 109 feet in length, is built with round white oak piles, each 30 feet long, driven at distances of 3 feet from center to center and secured with binders. On the south side of this row pine piles of 8 by 12 inches by 26 feet are driven in close contact and bolted to the binder and reenforced with a pine binder of 3 by 12 inches. The next section of this pier is 877.6 feet long, and is composed of two parallel rows of white oak piles, driven in close contact, at a distance of 14 feet from center to center of rows, and is divided into sections of about 32 feet each. For a length of 675 feet of this section the piles are 31 feet long, and for the remainder 32 feet long. The rows of piles are secured and bound in place by means of wales, binders, screw bolts, and tie rods, in a similar manner to those of the outer section of the north pier. On the south side of the north row a double sheeting of pine plank, 3 by 12 inches by 22 feet, is driven and spiked to the wales in a similar manner to the second section. The interior of this section has been filled with stone ballast to a height of 2 feet above datum, but in some places this ballast has settled somewhat below that level.

The outer section of this pier is similar in construction to the section last described, but is 16½ feet wide. It was constructed in 1893, and is 160 feet long.

In the work done in 1893, Wakefield triple-lap sheet piling of 3-inch planks was used.

The piers are protected on both sides by riprap, carried up on the lake sides to 11 feet and on the channel sides to 9 feet below datum.

Depth of water.—Before work was commenced upon this harbor the distance from the line of shore, in front of which the piers have been constructed to the natural depth of 12 feet of water in Lake Michigan, was about 870 feet, but as the work has progressed an extensive accretion has been formed to the northward of the harbor. The shore line now intersects the north pier at a distance of 700 feet outside, or to the eastward of the line of shore as it existed in 1879, and the contour line of 12 feet of water is about 450 feet outside that former line of depth, or more than 1,300 feet to the eastward of the line of shore of 1879.

A plat of soundings taken in April, 1894, shows a depth of 10 feet in the inner basin and between the piers, a decrease of half a foot since last year.

Operations during the fiscal year.—Under contract dated September 21, 1892, with Knapp & Gillen, of Racine, Wis., the north pier was extended 216 feet and the south pier 160 feet. The north pier extension is 20½ feet wide; the cross rows of piles are 24 feet apart. The average depth was about 20 feet; the cost per linear foot, $69.20. The south pier extension is 16½ feet wide, with cross rows 32 feet apart. Average depth, 12½ feet; cost per linear foot, $39.53. The riprap protection on the lake sides of the piers is carried up to 9 feet, and on the channel sides to 11 feet below datum.

Remarks and recommendations.—The outlook for a large increase in the commerce and manufactures of Waukegan is very encouraging, and in consequence the value of real estate has been greatly enhanced. The facilities rendered by the present harbor are not considered by the citizens of the place as being adequate to the requirements of the growing demands, and the extension of the harbor piers to the 16-foot contour in Lake Michigan has been strongly urged by the citizens of Waukegan.

In 1889 the amount by which it was thought necessary to extend each pier was 500 feet, which would make the north pier 1,760 feet and the south pier 1,525 feet long. As stated above, the present lengths are 1,868 and 1,287 feet, respectively, the north pier terminating in about 17 feet of water and the south pier in about 12. The south pier lacks, therefore, 238 feet of its projected length, and the need of extending it by this amount is urgent, since in prolongation of the south pier, and under the lee of the north pier, an extensive bar is forming which threatens to extend across the channel. The estimated cost of the pier extension is about $24,000. There appears to be immediate need of extending the north pier.

To deepen the basin to 12 feet, and to provide an entrance channel 90 feet wide and 12 feet deep, the projected depth, will require the removal of about 20,000 cubic yards of material, at an estimated cost of $5,000.

Six hundred and seventy linear feet of the north pier—namely, the north-and-south arm and 300 feet of the pier adjoining this arm on the east—is in a dilapidated condition and should be rebuilt at once. The estimated cost of this proposed reconstruction is $26,800.

About 800 cords of stone are necessary to supply the place of stone that has settled along the length of both piers under the influence of storms. Estimated cost, $5,600.

The amount (estimated) required for the completion of the present project ($61,000) is sufficient for the present needs of this harbor, and its appropriation is recommended for the fiscal year ending June 30, 1896.

APPROPRIATIONS.

Act of—	
August 30, 1852, for breakwater (outer)	$15,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	20,000
July 5, 1884	20,000
August 5, 1886	20,000
August 11, 1888	25,000
September 19, 1890	35,000
July 13, 1892	25,000
Total appropriations for harbor	190,000
Appropriation for outer breakwater (1852)	15,000
Total for present harbor	175,000

Money statement.

July 1, 1893, balance unexpended	$26,844.80
June 30, 1894, amount expended during fiscal year	22,961.57
July 1, 1894, balance unexpended	3,883.23
Amount (estimated) required for completion of existing project	61,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	61,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS FOR THE CALENDAR YEAR ENDING DECEMBER 31, 1893.

[Furnished by the mayor of Waukegan, Ill.]

Name of harbor, Waukegan, Ill.; collection district, Chicago, Ill.; nearest lighthouse, Waukegan, Ill.

Arrivals and departures of vessels.

Description.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam	10	Not obtainable.	10	Not obtainable.
Sail	25		25	
Total	35	....	35	....

Principal articles of export and import.

BY ALL WAYS OF TRANSPORTATION.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	IMPORTS—continued.	*Tons.*
Beer and ale	859	Hay	220
Brick	140	Hides	109½
Butter	25	Iron and steel	40,000
Cattle	652	Lath	680½
Hogs	209	Lime and cement	204
Iron and steel	42,500	Lumber	13,476
Leather, hair, and glue stock	495	Marble	120
Lumber	1,800	Merchandise, general	128,000
Sash, doors, and blinds	3,000	Mill stuffs	490
Sheep	512	Moldings, etc	81
Wool	40	Oats	496
		Oil	101
Total	50,232	Pork and beef	2½
		Poles, telegraph	51
IMPORTS.		Posts, fence	171
Bark, tan	1,019	Potatoes	366
Beer	2,933	Provisions	270
Brick	220	Sash, doors, and blinds	3,125
Butter	30	Shingles	1
Cattle	126	Stone	399
Cheese	1	Wagons and carriages	70
Coal and coke	97,671	Wood	1,450
Corn	134		
Flour	1,157	Total	293,174½

J J 22.

IMPROVEMENT OF FOX RIVER, WISCONSIN.

Object.—Originally to secure a cheap route of transportation from the Mississippi River to the Great Lakes and Atlantic seaboard. The improvement of the Wisconsin River having been abandoned, the present object is to obtain a navigable channel, as far as existing works will permit, from Portage, on the Wisconsin River, to the harbor of Green Bay, a distance of 160 miles.

Project.—The original project called for slack-water navigation on the Fox River by means of locks and dams, as part of the through transportation route. The present modified project is that recommended by the Board of Engineers of May 14, 1886, and is to deepen the Fox River by rock excavation and dredging from Montello to Green Bay to 6 feet depth, and from Portage to Montello to 4 feet depth; to widen the river channels to 100 feet throughout; to deepen the channel between De Pere and Green Bay; to dredge the channel in the Neenah River, and to remove the bar at the mouth of the Fond du Lac River.

Present works.—The present works are as follows:

	Upper Fox.	Lower Fox.	Total.
Locks	9	18	27
Dams	7	9	16
Canals	4	8	12
Total	20	35	55

Of the locks, 15 are of stone; 14 built by the United States and 1 by the canal company, but repaired by the United States in 1878. The remaining 12 are wooden locks, which have been rebuilt and repaired from time to time. No more masonry locks are to be built.

Of the dams, 1 is of masonry, 9 of cribs, 1 of piles, 1 of piles and cribs with movable weir, and 4 of brush and stone.

Of the canals, the one at Portage, 2 miles long, is revetted its entire length, on both sides, with a timber revetment. At Appleton, above the first lock, there is a cement-laid stone revetment wall, about 800 feet long, and from 16 to 20 feet high. It was built by the United States in 1879–'80. Below the guard gate at Kaukauna is a dry-stone revetment wall, about 1,200 feet long. It was built by the canal company, and may have to be rebuilt in places, as it shows signs of yielding. Also, in the left bank of the fourth level at Kaukauna, there is a "core wall" of cement masonry 77 feet long, built in 1893–'94; in the right bank of the same level, two core walls, one 600 feet long, built in 1892–'93, and one 143 feet long, built in 1893–'94; and in the right bank of the fifth level, one 376 feet long, built in 1893–'94.

Depth of water.—The fall from Menasha to Green Bay is about 170 feet, and on the Upper Fox, from Portage to Lake Winnebago, about 30 feet. Previous to any improvements the river was obstructed by rapids and at places portages had to be made.

As stated above, the project contemplates a channel 6 feet deep from Green Bay to Montello, and one 4 feet deep from Montello to Portage; these channels to have a minimum width of 100 feet.

On the Lower Fox, which is thoroughly canalized, the crests of the dams are uniformly 6 feet above the breast walls of the locks immediately below, and where rapids are passed by means of several locks the breast wall of any one is 6 feet below the lower miter sill of the one next above. In the levels formed by the different dams and locks, dredging has been and is still being done where necessary to secure the projected depth. Except, therefore, in places where this dredging is not yet completed there is always throughout the Lower Fox a depth of 6 feet, unless the pools are drawn down below the crests of the dams by the millers using more water than they are entitled to. The water stood continuously below the crest of the Menasha Dam from the middle of July, 1893, to the early part of April, 1894, and at times was as much as 1½ feet below. In other words, the water runs over this dam only during floods or when there is more water flowing in the river than the mills are able to use. This has been the case for more than eight years, and was the cause of the suit brought by the United States in 1886 to restrain the water-users at Neenah and Menasha from drawing the Menasha Pool (Lake Winnebago) down below the crest of the dam. This case is still pending, and will never be brought to an issue if the water-users can prevent it, since as long as it remains undecided they are enjoying all the advantages that would follow a decision in their favor. The Menasha Channel, dredged at great expense in rock and hardpan to a depth of 6 feet below the crest of the Menasha Dam, is now the shallowest part of the waterway from Oshkosh to Green Bay. For the status of the above-mentioned suit and of others of kindred nature, attention is invited to the appended report of Mr. J. H. M. Wigman, United States attorney for the eastern district of Wisconsin, dated June 28, 1894.

The Upper Fox is not so thoroughly canalized as the Lower, and the depth available for navigation is therefore more largely dependent on the amount of water flowing in the river. At a fairly low stage there is a minimum depth of about 3 feet.

During the fiscal year ending June 30, 1894, navigation closed on the Upper Fox November 15. 1893, and on the Lower Fox the 22d of the same month.

It was resumed from Fort Winnebago Lock to Green Bay on the 20th of April, 1894.

Operations during the fiscal year.—The new lock at Portage was completed.

The dredging in Grignon Rapids was completed. This work has resulted, as intended, in a channel 100 feet wide and 7 feet deep below the crest of the Appleton Upper Dam, extending the entire length of the rapids (about 4,000 feet).

The dredging in the river between Rapide Croche Dam and Wrightstown bridge was completed. This work has resulted in a channel 100 feet wide, 1 foot deep below the lower miter sill of Rapide Croche Lock, and about 8,000 feet long.

The right wing wall and a portion of the left wing wall of the Kaukauna fourth lock were removed and rebuilt of cement-laid rubble masonry, and core walls of similar construction founded on bed rock were built in the banks immediately above the wing walls, that in the right bank being 143 feet long and that in the left 77. In the right bank of the fifth level a similar core wall, 367 feet long, starting 98 feet above the fifth lock, was constructed.

A masonry wasteweir and culvert at the head of the combined lock, to regulate the height of water in this level and to afford a means of draining the level, if necessary, was built.

A new dam of crib work was constructed above Berlin Lock, and a pile, brush, and stone protection 160 feet long was constructed on each side just below the dam. All that remains to complete the work is to open up the channel above the new dam and to close that above the old.

For details of the work, attention is invited to the report of Assistant Engineer Samuel Whitney, appended hereto.

Remarks and recommendations.—The commercial use made of this waterway from Portage to Berlin Lock is inconsiderable; thence down to Oshkosh it increases, and from the latter place all the way down to Green Bay it is quite extensive.

The following remarks are from the report of Maj. Charles E. L. B. Davis, Corps of Engineers, 1891:

> This river has its effect upon rates an all freight carried to points in the Fox River Valley, which is the most thickly settled portion of the interior of Wisconsin and an important manufacturing region. All freights during the season of navigation, and particularly heavy freights, are reduced to near the price of water carriage, whether carried by boat or by the competing railroads, and for the reason that it is a regulator of freight it is of such value that the works should be maintained and the navigation improved at least to the extent contemplated by the modified project of 1884.

It is important that the suit to restrain the water-users at Neenah and Menasha from drawing the water below the crest of the Menasha Dam should be tried and decided at once. . There can be little doubt as to the outcome of the trial, but until vessel-owners can know whether to count on 6 feet of water, or only so much as the millers are willing to allow, it is futile to expect that any but the smallest craft will navigate the Lower Fox. An appropriation of $100,000 is recommended for the fiscal year ending June 30, 1896.

List of appropriations made by Congress for the improvement of the Fox and Wisconsin rivers, Wisconsin.

Act of—	
March 2, 1867, for snag boat on Wisconsin River	$40,000
July 10, 1870, for improving Wisconsin River	100,000
June 10, 1872, for purchase of works on Fox River from Green Bay and Mississippi Canal Company	145,000
March 3, 1873, for improving Fox and Wisconsin rivers	300,000
June 23, 1874	300,000
March 3, 1875	500,000
August 14, 1876	270,000
June 18, 1878	250,000
March 3, 1879	150,000
June 14, 1880	125,000
March 3, 1881	125,000
August 2, 1882	200,000
July 5, 1884	160,000
August 5, 1886, for improving Fox River	56,250
August 11, 1888, for improving Fox River	100,000
September 19, 1890, for improving Fox River	100,000
July 13, 1892, for improving Fox River	75,000
Total	2,996,250

Money statement.

July 1, 1893, balance unexpended	$50,420.86
June 30, 1894, amount expended during fiscal year	34,918.39
July 1, 1894, balance unexpended	15,502.47
July 1, 1894, outstanding liabilities	2,464.37
July 1, 1894, balance available	13,038.10
Amount (estimated) required for completion of existing project	270,750.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. SAMUEL WHITNEY, ASSISTANT ENGINEER.

U. S. FOX RIVER IMPROVEMENT, ENGINEER OFFICE,
Oshkosh, Wis., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations upon "improving Fox River, Wisconsin," from Portage to Green Bay, for the fiscal year ending June 30, 1894. The work done during the year consisted principally in completing the Portage Lock; completing the dredging of the channels at Grignon Rapids, Rapide Croche, and below the combined locks to a depth of 6 feet below low water surface, and to a width of 100 feet; in rebuilding the canal banks at Kaukauna, placing them on bed rock, and the construction of a dam near Berlin Lock.

REPAIRS OF LOCKS, ETC.

Rebuilding canal banks at Kaukauna.—The work of rebuilding a portion of the embankments of the fourth and fifth levels of the canals at Kaukauna (placing them on bed rock) was resumed on the 1st of December, 1893, and completed April 30, 1894, except the backing of the wall in the fifth level, which was done by dredge No. 3, and finished May 8, 1894. One hundred cubic yards of earth were removed from in front of the culvert under the right bank of the second level, so the leakage of water from the level above would run through the culvert during the progress of the work instead of following down the canal.

Right bank of the fourth level.—The old dry masonry wing wall above the fourth lock, containing 55 cords of stone, was removed and 1,305 cubic yards of earth and 20 cords of loose rock, overlying the bed rock, were excavated from the trench, preparatory to building wing and core wall of cement masonry.

The wall contains $387\frac{20}{27}$ cubic yards of cement masonry and is 197 feet long. Fifty-four feet of this is wing wall of the lock, and is 5 feet wide at the bottom and 4 feet at the top; the remainder (143 feet) is 5 feet wide at the bottom and 2 feet at the top. The height of the wall varies from 15 to 17 feet. One thousand five hundred cubic yards of earth were filled in on front and rear of wall, completing the same.

Left bank of the fourth level.—Forty-three cords of stone were removed from the dry-masonry wing wall above the fourth lock, and 220 cubic yards of earth excavated from the trench preparatory to building a cement-masonry wing and core wall; 152 cubic yards of cement masonry were laid, and the earth from the trench replaced as backing to the wall, completing a wall 131 feet long.

Right bank of the fifth level.—There were 3,750 cubic yards of clay and hardpan and 18 cords of loose rock wheeled from a longitudinal trench excavated in the canal bank preparatory to building a cement-masonry core wall. As the water could not be bailed out by hand from the trench, a pump and pumping engine were set up and the water pumped from the trench. Seven hundred and twenty cubic yards of cement masonry were laid, completing the building of a core wall, commencing at a point 98 feet above the head of the fifth lock and extending to a point 465 feet above the lock. The wall is 367 feet long, 5 feet wide at the bottom, and 2 feet wide at the top, with an average height of 15½ feet.

The building of the walls has resulted in the stopping of the leaks underneath and through the old embankments. The stone used in the construction of these walls was quarried from the bed of the third level of the canal at Kaukauna and hauled by teams to the site of the walls.

Wasteweir and culvert at head of combined locks.—This work was begun July 8 and completed August 31, 1893. One thousand four hundred and seventy cubic yards of clay were excavated; 211 cubic yards of cement masonry were laid in the breast and wing walls and 750 cubic yards of clay puddled in rear of them. The apron and footwalk contained 2,841 feet B. M. pine timber and plank. The stone used was part of that dredged from the channel of the river below the lock. The object of this weir is to regulate the height of water in the level which extends from the combined locks to Little Chute second lock, and of the culvert, to afford a means of draining this level when necessary.

CONSTRUCTION OF LOCKS, ETC.

Portage Lock.—This lock was commenced November 21, 1892, and completed July 31, 1893. The work done during the present fiscal year was as follows: One thousand one hundred and seventy-six cubic yards of sand were placed as backing to the walls, 421 cubic yards of which were dredged from Portage Canal; 170 cubic yards were taken from the dredge bank at the side of the canal, and the remainder (585 yards) was dredged from a bar in Fox River, within 200 feet of the lower end of Fort Winnebago Lock. All of the material was loaded on scows by dredge No. 5, towed to the lock by tugboat *Fox*, and then wheeled to rear of the lock walls.

The bottom of the canal for a distance of 20 feet below the lower end of the lock was well riprapped with 11 cords of stone, brought from Fort Winnebago Lock.

The construction of this lock was fully described in my annual report of last year. Upon the completion of this lock the pumping machinery and other tools were loaded on to a barge in readiness to be taken to Berlin for use in the construction of Berlin Dam.

Dam near Berlin Lock.—This dam was begun in July, 1893, and finished in November, 1893, excepting the pile and brush protection along the banks of the river below the abutments and placing some material for backing at the rear of the dam. This dam is of crib work filled with stone, and is 200 feet long between the abutments, 12 feet 6 inches high, 2 feet 8 inches wide at the base, including an apron 16 feet 4 inches wide. The abutments are crib work to low-water surface and of cement masonry to a height of 7 feet 6 inches above that point. The manner of constructing the dam was this: Dredge No. 5 having dredged her way to the proposed site, dug out a pit, throwing the dredged material into a bank surrounding the pit. When the partially constructed cribs had been towed into this basin the dredge moved out and closed the exit channel. The cribs were then sunk by filling them with stone. Pumping machinery was set up and the pit pumped out for convenience in planking the top of the dam and framework of apron. The top of the dam was covered with one thickness of 3-inch pine plank, the top of the framework of apron with one thickness of 3-inch oak plank, and the back of the dam was sheet piled with Wakefield's triple-lap sheet piling, which was driven to a depth of 6 feet below the bottom of the dam.

The river banks for a distance of 160 feet below the abutments were protected by pile and brush piers. Piles were driven at distances of 8 feet apart in two rows 10 feet apart, and the space between the rows filled with brush mats and stone to a level with the crest of the dam. After the mats and stone had been put in place, wale timbers were put on the outside of both rows of the pile piers and held in place by 1-inch tie rods of iron passing through both front and rear wale timbers. The amount of material dredged from the pit for the dam and abutments was 4,965 cubic yards, 1,500 cubic yards of which had to be rehandled. Dredging was suspended on October 20, 1893, and the dredge moved to a short distance below Berlin Lock and laid up for the winter. Work was resumed May 4, 1894, by dredge No. 5, and dredge No. 4 was also employed from June 4 to June 10, 1894, and up to June 10 dredge No. 5 removed 12,234 cubic yards and dredge No. 4 3,447 yards of material from the pits for the protection piers, 2,660 cubic yards of which were placed as backing to the dam and the remainder, 13,021 yards, was deposited on the banks of the river at the rear of the pile and brush protection. As no regular crew was employed to run the pile driver, the crew on dredge No. 4 was employed when needed for sharpening and driving piles for both piers, and up to June 10, 1894, 80 piles have been driven for the piers; brush was cut and made into 857 mats, and the mats sunk in place in the piers with 120 cords of stone. Six hundred and ninety-seven linear feet of wale timbers were framed and secured in place, completing the construction of pile and brush protection piers. All that remains to complete the work is to change the direction of the river so that it will run over the new dam; 1,600 cubic yards of material have already been removed up to June 10, 1894, and deposited at the side of the channel.

DREDGING LOWER FOX RIVER.

Channel below Rapide Croche Lock.—The object of this work was to provide a channel 100 feet wide and 1 foot deep below the level of upper surface of the lower miter sill of Rapide Croche Lock, between the dam and Wrightstown bridge, a distance of about 8,000 feet.

Dredge No. 3 worked here from August 11 to November 14, 1893, removing 19,303 cubic yards of gravel, bowlders, and clay, of which 2,421 yards were banked on the left side of the channel, 12,049 yards were loaded into scows, towed by steamer *Boscobel* to deep water near right bank of the river and dumped, and 4,833 yards were loaded in scows, towed to Little Kaukauna dam, and dumped as backing to the dam.

Dredge No. 2 was employed from October 1 to November 14, 1893, removing 9,230 cubic yards of gravel and clay, 6,089 yards of which were banked on the left side of the channel, and 3,141 yards loaded in scows, towed by steamer *Boscobel* to deep water, and dumped.

Dredging was suspended on November 14, 1893, and the plant laid up for the winter. Work was resumed by dredge No. 3 on May 9, 1894, and up to June 10 she removed 6,284 cubic yards of material, 702 yards of which were placed on the bank of the river and the remainder, 5,582 yards, was put into dump scows, towed to deep water by tugboat *General Warren*, and dumped. Dredge No. 2 resumed work on May 11, 1894, and removed 3,296 cubic yards of material, placed in dump scows, towed by tugboat *General Warren* to deep water, and dumped. Total number of cubic yards dredged up to June 10, 1894, is 38,113. The dredging of this channel will be completed at the end of this fiscal year.

Channel below Combined Locks at Little Chute.—This work was done by dredge No. 2 between August 31 and October 3, 1893. It consisted in excavating to a depth of 6 inches below the level of the upper plane of lower miter sill, of the Combined Locks, a channel 100 feet wide and 900 feet long, commencing just below the Combined Locks. Four thousand three hundred and twenty-nine cubic yards of material (limestone rock and gravel), 889 yards of which had to be handled twice, were removed and deposited on a bank at the left side of the channel.

Channel at Grignon Rapids.—Dredges Nos. 2 and 3 continued this work from the beginning of the fiscal year until August 24, 1893, when it was finished. Dredge No. 2 removed 4,197 cubic yards and dredge No. 3, 4,608 yards, the material being solid rock, bowlders, and gravel. The rock (2,873 yards) was thrown into a bank on the left side of the river for future use; the other material (5,932 yards) was loaded into dump scows, towed into deep water in Little Lake Buttes des Morts, and dumped. Drilling and blasting was necessary to remove an area of about 30 by 50 feet; 19 holes were drilled to a depth of 4 feet and the rock blasted by dynamite and then taken out by dredges. The channel was sounded by means of a framework attached to the side of a 90-foot scow, with a crosspiece at proper depth. The scow was guided along the entire length of the channel, and any shallow spots discovered were removed.

The work of dredging in the Grignon Rapids was begun May 25, 1891, and has resulted, as intended, in a channel 100 feet wide and 7 feet deep below the level of the crest of Appleton upper dam from the Milwaukee and Northern Railroad bridge throughout the entire length of the rapids (about 4,000 feet). In all, 65,831 cubic yards of limestone rock (requiring some drilling and blasting), bowlders, and hardpan have been removed, at a total cost of $18,647.12, or 28¼ cents per yard.

Very respectfully, your obedient servant,

SAMUEL WHITNEY,
Assistant Engineer.

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

REPORT OF MR. J. H. M. WIGMAN, U. S. ATTORNEY.

GREEN BAY, WIS., *June 28, 1894.*

MAJOR: Hon. Richard Olney, by his letter dated October 27, 1893, directed me to take charge of all the cases and litigations on behalf of the United States then in the hand of Mr. A. E. Thompson, the special assistant U. S. attorney.

At the time I took charge of such cases and litigations there were pending in the circuit court of the United States for the eastern district of Wisconsin, three cases for damages for flowage, each of which was an appeal from the award of the commissioners, namely:

ALBERT HIRTE V. THE UNITED STATES.

Hirte filed his petition December 20, 1886, claiming $718 damages for flowage to his lands; on December 19, 1888, the commissioners made an award by which they allowed him $75, and he appealed. Hirte made a proposition to accept a judgment for $200 without costs. The proposition was submitted to the Attorney-General, and by his direction accepted, and in pursuance of such compromise judgment was entered against the United States on November 5, 1893, for $200.

PHILLIP CASSODAY V. THE UNITED STATES.

This also was an appeal from the award of the commissioners. Cassoday claimed $1,800 damages for the flowage of his lands; the commissioners awarded him nothing; he made a proposition to settle the case by taking judgment for $200. It would have probably cost the United States $400 to try the case, and as he had sustained some damages a recommendation was made to offer him a judgment for $100; and by the direction of the Attorney-General his acceptance was accepted, and on November 5, 1893, judgment was entered against the United States for $100, without costs.

PATRICK M'GRAY *v.* THE UNITED STATES.

Also an appeal from the award of the commissioners.

Patrick McGray filed his petition, claiming $1,700 damages. Commissioners were appointed September 6, 1886. The commissioners made an award that the petitioner was entitled to nothing.

The claimant died; his estate was settled without any reference to this claim.

James McGray, a son, claiming as heir-at-law, appealed, or rather attempted to appeal. A motion to dismiss the appeal was made and pending. As there was no question that the McGray estate had sustained some damage, and the owners of the adjoining lands had been awarded damages, the proposition to accept a judgment for $375 in settlement was, by direction of the Attorney-General, accepted, and on March 28, 1894, judgment was entered against the United States for $375.

On the 8th day of November, 1886, a suit in equity was commenced by the United States in the circuit court of the United States for the eastern district of Wisconsin against the Winnebago Paper Company and others, owners of the water power on the Fox River, praying that the defendants in said action should be enjoined and forbidden from taking water from the pool of the Fox River below the crest of the dam at Menasha.

A supplemental complaint was filed on the first Monday in March, 1892. Two crossbills were filed in said action against the United States, one by the defendants, users of water from the Menasha Channel, and the defendants, users of water from the Neenah Channel, and the other by the Green Bay and Mississippi Canal Company. To such crossbills pleas had been filed by Mr. Thompson raising the question as to whether the United States could be made defendant without its consent. These pleas were argued and determined against the United States. Exceptions to each of said crossbills were then filed, and were argued in September, 1893, and determined against the United States.

Leave to demur or answer was thereupon granted to the United States, the time for which has been from time to time extended and not yet expired. Either a demurrer or answer to the crossbills will be filed before the next term of said court.

An action of ejectment is also pending in the circuit court of the United States for the eastern district of Wisconsin against the Manufacturing Investment Company, lessees of the water power from the Green Bay and Mississippi Canal Company, whose mills are situated near the fourth lock in Appleton. They made an excavation and built a retaining wall near the lock on land claimed by the United States. The defendant answered, and set up a counterclaim; to this counterclaim, the Government, by Mr. Thompson, demurred. The demurrer was argued by Mr. Thompson, and determined in favor of the United States.

This action is at an issue, but has not yet been tried.

Yours, very respectfully,

J. H. M. WIGMAN,
U. S. Attorney, Eastern District of Wisconsin.

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

List of articles transported on Fox River, Wisconsin, during the season of 1893.

Articles.	Quantity.	Articles.	Quantity.
	Tons.		*Tons.*
Apples	8	Lumber	9,294
Beer	55	Logs	104.028
Brick	11,061	Merchandise	1,913
Clay	527	Nails	4
Coal	20,096	Pig iron	100
Cord wood	18,130	Pulp wood	7,146
Cedar posts	279	Salt	2,237
Drain tile	103	Sand	7,171
Flour, millstuff, etc	1,739	Sewer pipe	565
Fish	204	Shingles	1,406
Gravel	2,803	Stone	12,234
Laths	82		
Lime	425	Total	202,443
Live stock	830		

Passengers, 50,134.

List of boats navigating Fox River between Portage and Green Bay, Wis., June, 1894.

Name of boat.	Draft.	Tonnage.	Steam or sail.	Name of boat.	Draft.	Tonnage.	Steam or sail.
	Feet.				*Feet.*		
Evalyn	5½	150.66	Steam.	Emma (scow)	4½	45	Sail.
K. M. Hutchinson*	4½	189.96	Do.	Venture (scow)	6	91	Do.
Henrietta*	5	125	Do.	Julia (scow)	5	44	Do.
Fashion †	3½	50	Do.	Brunette (scow)	4	65	Do.
City of Berlin †	3	125	Do.	Long Tom (barge)	5	145	Tow.
B. F. Carter	5	125	Do.	Niebauer (barge)	3	20	Do.
J. H. Marston	4½	150	Do.	Hustler (barge) †	2½	90	Do.
John Lynch †	3	40	Do.	D. A. Cady (barge) †	4	125	Do.
Ossian Cook	5	175	Do.	Jumbo (barge)	5	97	Do.
O. B. Reed*	3½	75	Do.	A. P. Grover, (schooner).§	(‡)	(‡)	Sail.
Hustler†	2½	(‡)	Do.				
Laura May	3	5.91	Do.	P. B. Locke (schooner).§	(‡)	(‡)	Do.
George Lacy †	2 7/12	25	Do.				
John Dennessen	5	15.40	Do.	C. H. Johnson (schooner).§	(‡)	(‡)	Do.
M. Burnette	5	65	Do.				
Nettie Dennessen	5½	13.60	Do.	John Schuette (schooner).§	(‡)	(‡)	Do.
D. A. Cady (tug) †	2	50	Do.				
M. D. Moore (tug)*	3	53	Do.	Transfer (schooner)§	(‡)	(‡)	Do.
Agnes C. (tug)	6	10	Do.	Ogden (schooner) §	(‡)	(‡)	Do.
Wa Wa (tug)	4½	10	Do.	Red, White and Blue (schooner).§	(‡)	(‡)	Do.
Volunteer (tug)	5	17	Do.				
D. L. Libbey (tug)*	3½	60	Do.	Mineral State (schooner).§	11	(‡)	Do.
Georgia (scow)	5½	78	Sail.				
Eclipse (scow)	3½	70	Do.	Ida Torrent§	(‡)	(‡)	Steam.

*Boats that run to Winneconne occasionally.
†Boats that run above Oshkosh.
‡Not given.
§Boats that run between Green Bay and De Pere.

Number of lockages on Fox River, Wisconsin, for the calendar year 1893.

No.	Lock.	Lockages.	No.	Lock.	Lockages.
1	Depere	545	16	Appleton, second	446
2	Little Kaukauna	366	17	Appleton, first	629
3	Rapide Croche	307	18	Menasha	505
4	Kaukauna, fifth	425	19	Eureka	495
5	Kaukauna, fourth	425	20	Berlin	598
6	Kaukauna, third	409	21	White River	116
7	Kaukauna, second	422	22	Princeton	121
8	Kaukauna, first	426	23	Grand River	136
9	Little Chute, fourth } combined	380	24	Montello	67
10	Little Chute, third } combined	380	25	Governor Bend	65
11	Little Chute, second	378	26	Fort Winnebago	108
12	Little Chute, first	375	27	Portage	100
13	Cedars	380			
14	Appleton, fourth	393		Total	9,439
15	Appleton, third	442			

J J 23.

OPERATING AND CARE OF LOCKS AND DAMS ON FOX RIVER, WISCONSIN.

The expenditures for maintaining the existing depth of navigation throughout the Fox River and canals; for repairs to mechanical constructions that have been completed and in use, but afterwards injured by flood or otherwise; for current repairs to old locks and dams and lock houses, and for lock-tenders' services have been paid from the indefinite appropriation for "operating and care of canals and other works of navigation" provided by section 4 of river and harbor act of July 5, 1884.

In accordance with this section an itemized statement of the expenditures is appended hereto.

The work during the fiscal year has consisted principally in dredging the channels of the river and canals and in making repairs of boats, dredges, lock houses, locks, dams, and canal banks.

For details of the work attention is invited to the appended report of Assistant Engineer Samuel Whitney.

Money statement.

July 1, 1893, balance unexpended	$14,456.41
Amount allotted for fiscal year ending June 30, 1894	32,430.55
	46,886.96
June 30, 1894, amount expended during fiscal year	36,958.24
July 1, 1894, balance unexpended	9,928.72
July 1, 1894, outstanding liabilities	1,313.13
July 1, 1894, balance available	8,615.59
Amount (estimated) for expenditure in fiscal year ending June 30, 1895	* 30,882.37
Amount available for fiscal year ending June 30, 1895	39,497.96

REPORT OF MR. SAMUEL WHITNEY, ASSISTANT ENGINEER.

U. S. FOX RIVER IMPROVEMENT, ENGINEER OFFICE,
Oshkosh, Wis., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations upon "operating and care of canals and other works of navigation, on the Fox River," for the fiscal year ending June 30, 1894:

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* Amount allotted if estimate is approved.

Work during the year consisted principally in constructing an apron along the front of Rapide Croche Dam; partially rebuilding Little Chute, first lock; building four new gates for Appleton, first lock, and four for Little Chute, second lock; repairs of lock houses at Kaukauna (fifth), Cedars, Berlin, and Princeton locks; rebuilding the foot walks, winch house, winch track, etc., over the sluice ways of Appleton upper dam; making necessary repairs of plant; removing bars in the Upper Fox River by dredging, and in making incidental repairs of locks, dams, and canal banks.

Navigation was maintained from Green Bay to Portage during the year, except when closed by ice.

REPAIRS OF LOCKS, ETC.

Depere Lock.—Twenty-five cubic yards of earth were removed from the rear of coping timbers of the upper wing walls, preparatory to replacing the decayed coping with new material. The canal face of the crib work of wing walls was covered with two thicknesses of 2-inch vertical sheet piling from top of wing wall to bed of canal; over this, one thickness of 4-inch plank was placed horizontally from the top of the wing wall to surface of water for fender plank. The valve rods in the upper gates became disconnected from the valves, the gates taken out, valve rods repaired, and the gates replaced.

Depere Dam.—The bulkheads at the sides of the five flumes in the right half of the dam were rebuilt. Provision was made to close the flumes with plank which can be easily removed if necessary during high water, so that the flumes can be used as sluice ways. The upper course of timber of the crib connecting the right abutment of the United States dam with the abutment of the old dam, being badly decayed, was torn off and a course of new timber put in place.

Little Kaukauna Lock.—No repairs required.

Little Kaukauna Dam.—Dredge No. 3 was employed to remove a portion of the old spar dam so that scow loads of dredged material could be taken to the rear of the pile dam and dumped where needed for repairs of the backing. Five thousand and sixty-four cubic yards of clay and gravel were placed as backing to the dam, 4,853 yards of which was a part of that dredged from below Rapide Croche Lock for the purpose of widening and deepening the channel between the lock and Wrightstown bridge, and the remainder, 211 yards, was wheeled from the bank of the river to a point near the right abutment, not accessible to scows.

Rapide Croche Lock.—No repairs needed

Rapide Croche Dam.—This dam is of crib work, filled with stone; it is about 11 feet high and the width at the base is but 14 feet. Since it was constructed (in 1876) it has gradually moved downstream, and in order to prevent further movement an apron of cribwork 10 feet in width and 7 feet in height was built and sunk in front of the dam and filled with stone. Then that part of the dam in front of the crest (about 6 feet in width) and the new crib work were covered with 3-inch plank laid three-fourths of an inch apart and with downstream slope of 3 inches to 1 foot. The left abutment was extended downstream 24 feet by crib work filled with stone. Before sinking the crib work, all bowlders, loose rock, etc., were removed from the rock bed of the river upon which the cribs rest. Two hundred cubic feet of large stone and 19 cords of rubble stone were placed to riprap the bank of the river for a distance of 70 feet below and 75 feet above the right abutment. The stone used to fill the new apron and the crib extension of the left abutment is a part of that dredged from the channel at Grignon Rapids and was transported to the dam by tugboat *General Warren*, and that used to riprap the right bank of the river was brought from Kaukauna quarry by the same boat.

Canal banks at Rapide Croche.—Eleven thousand five hundred and eighty cubic feet of large stone were placed to riprap the river slope of the canal bank for a distance of 240 feet above the head of the lock, completing the protection of the bank where exposed to the current of the river. The stone used for this work was brought from the quarry at Kaukauna by tugboat *General Warren.*

Kaukauna Fifth Lock.—Sand and mud that had washed into the upper gate recess, which prevented the opening of the gates, was removed by means of a hand dredge.

Lock house at Kaukauna Fifth Lock.—An addition 15 by 20 feet was built to the lock house for use as a kitchen and wood shed.

Kaukauna Fourth Lock.—Slight repairs were made to the chains of the platform valves.

Kaukauna Third Lock.—Slight repairs were made to the hangings of all the gates and the chains of the platform valves.

Kaukauna Second Lock.—No repairs needed.

Kaukauna First Lock.—A new goose neck was made for one of the suspension rods of one of the lower gates, and the gate spars strengthened by fastening oak strips on under side.

Kaukauna warehouse.—The tin covering of the roof was painted two coats of mineral paint.

Kaukauna Dam.—The cribs at the ends of the 70-foot needle sluiceway were entirely rebuilt and filled with stone. Twenty-three broken trestles, supporting the footwalk leading from the left abutment to sluiceway, were replaced by new trestles.

Guard gates at head of Kaukauna Canal.—No repairs required.

Combined Locks at Little Chute.—Slight repairs were made to the valve gearing in the middle platform.

Little Chute Second Lock.—(Right lower wing wall.) The fender timbers along the face of the wall, which had become badly decayed, were replaced by 8,560 feet, B. M., of pine timber, and a new plank walk was laid along the top of the wall for a distance of about 100 feet below the lock.

Building new lock gates.—The old gates were removed and four new solid timber gates made and hung in place. The gate hangings were all repaired, new hand rails made and placed, and the capstan platforms were leveled up and put in good repair.

Little Chute First Lock.—This lock was put in thorough repair during the winter of 1893–'94. The old timber and plank facing of inner face of lock walls was entirely torn off; new middle girts and posts of oak were framed and secured to walls, and the framework covered with two thicknesses of 2-inch plank; the lower hollow quoins were replaced by new ones; the old capstan platforms were torn down, and four new ones built in place.

Little Chute Dam.—No repairs made.

Canal banks at Little Chute.—No repairs made.

Cedars Lock and Dam.—No repairs required.

Lock house at Cedars Lock.—The lock house was painted two coats inside and out.

Appleton Fourth Lock.—One new gate spar was made and attached to the gate.

Appleton Lower Dam.—The truss beams supporting the gates, the winch house, winch track, arms of gates, and hand rail of footwalk over the sluiceways were painted one coat.

Appleton Third Lock.—New fender planks were placed on lower right gate, and 1,908 feet, B. M., pine timber were framed and bolted in place to repair the coping of lower right wing wall.

Appleton Second Lock.—Fender planks were framed and placed on upper gates.

Appleton First Lock.—The old gates were removed and four new solid timber gates made and hung in place. New hand rails were put on the new gates, and a new gate spar for upper right gate was made, and a spar for lower left gate repaired.

Appleton Upper Dam.—The old winch house, winch track, and footwalk over the sluiceways were entirely rebuilt and painted two coats, and the old arms of gates and the trussed beams supporting the gates were painted one coat.

Menasha Lock.—A broken valve rod on the lower left hand gate was taken off, mended, and replaced.

Menasha Dam.—Nothing done to this dam.

Canal banks at Menasha.—(See Dredging Lower Fox River.)

Eureka Lock.—No repairs required.

Eureka Dam.—Sink holes in the backing of the dam were filled with 45 cubic yards of gravel, transported from a dredge bank at Sacramento by the steamer *Fox*.

Berlin Lock.—No repairs made.

Lock house at Berlin Lock.—The roof was reshingled; 200 linear feet of decayed crown molding of cornice replaced by new material; the eaves troughs and conductor pipes were put in good repair and painted, and slight repairs made to the outside cellar door and frame. The walls and ceiling of the kitchen, dining room and one bedroom were papered, and the kitchen floor painted one coat.

White River Lock and Dam.—No repairs were made during the year.

Princeton Lock and Dam.—No repairs made.

Lock house at Princeton Lock.—The roof was reshingled; the hips of the roof were covered with new tin shingles; the valleys lined with new tin, and the eaves troughs painted one coat.

Grand River Lock and Dam.—No repairs needed.

Lock house at Grand River Lock.—No repairs required.

Montello Lock and Dam.—No repairs done.

Montello Levee.—No repairs required.

Governor Bend Lock and Dam.—No repairs needed.

Fort Winnebago Lock.—No repairs required.

Portage Canal.—No repairs made.

Portage Levee.—No repairs made during the year.

DREDGING UPPER FOX RIVER.

Dredge No. 5 completed the work of dredging mud and sand from bars in the river between Grand River Lock and the head of Lake Apuckawa on July 5, 1893, removing 964 cubic yards of material. She was then towed by tugboat *Fox* to the foot of Fort Winnebago Lock, where she removed 187 cubic yards of sand from the turning place for boats. The dredge then proceeded to the head of Portage Canal for the purpose of removing small bars between the head of the canal and Wisconsin street bridge at Portage. One thousand one hundred and seventy cubic yards of mud and sand were taken out of the canal, 421 cubic yards of which were loaded on flat scows for use in backing the walls of the Portage Lock, and the remainder (749 yards) was placed on the right bank of the canal. The dredge then went to a point 200 feet below Fort Winnebago Lock and removed 2,211 cubic yards of sand from the bar at that place, 585 yards of which were placed on flat scows, taken to Portage Lock, and placed for backing the walls. The removal of this bar was completed on July 31, 1893, and the dredge was then towed by tugboat *Fox* to foot of Princeton Lock, and commenced the removal of all bars in the river between that point and section post 52, completing the work on August 23, 1893. From the bars below the lock the dredge removed 1,632 cubic yards of sand, and 7,847 cubic yards from bars between section posts 51 and 52. The dredge was then towed to Berlin, August 24, to excavate the pit for the new dam. Dredge No. 7, loaned to the city of Oshkosh July 9, 1892, by authority of the Secretary of War, was returned to Eureka Lock on the 19th of August, 1893, and commenced the work of removing bars in the river between the foot of the lock and section post 24. Twenty-nine thousand seven hundred and ninety-seven cubic yards were removed, 1,216 yards of which had to be rehandled in order to place it at a safe distance from the channel of the river. The removal of bars necessary to be done for the season having been completed, dredging was suspended on October 14, 1893, and the dredge towed to Eureka Lock by tugboat *Fox*, where she was laid up for the winter and placed in charge of the lock tender. Dredging was resumed on May 11, 1894, at the point where work was suspended last season, at a point between section posts 23 and 24. Eleven thousand nine hundred cubic yards of sand and clay were removed from bars in the river, 3,237 yards of which were rehandled and deposited on the right bank of the river, and 6,339 yards were dumped in the river at the side of the channel and will have to be rehandled in order to place it on the river bank. Dredge No. 4 having completed the work at Menasha, in connection with canal banks at Rapide Croche (loading large pieces of stone on scows, to be used as riprap for the canal banks) on the 20th of August, 1893, was towed as far as Omro by the tugboat *General Warren*, then by tugboat *Fox* to a short distance above Eureka Lock, and on August 23, 1893, began the work of removing bars in the river between that point and section post 32 (near Berlin). From between the lock and section post 28, 4,252 cubic yards of sand were removed; between section posts 28 and 29, 2,164 yards; between section posts 29 and 30, 2,266 yards; between section posts 30 and 31, 2,890 yards, and between section posts 31 and 32, 1,250 cubic yards, making a total of 12,822 cubic yards of material excavated. Two thousand four hundred cubic yards of this material had to be rehandled in order to place it where it would not run back into the channel. The removal of all bars between Eureka Lock and Berlin was completed on September 22, 1893, and on September 23, the dredge went to Berlin to be laid up for the winter.

DREDGING LOWER FOX RIVER.

Dredge No. 4 completed the dredging of the channel of Fox River below De Pere on July 1, 1893. She was then towed to Menasha, by tugboat *General Warren*, for the purpose of cleaning the channel of the river from the lower end of to a point 4,000 feet below the lock. The dredge arrived at Menasha on July 5, but did not commence dredging until the 7th, as some slight repairs had to be made to the machinery and the long spuds changed for a set of shorter ones. Five thousand two hundred and thirty-three cubic yards of material were removed from the channel below the lock, 2,083 yards of which were dumped on the dredge bank at the left side of the channel, and 1,800 yards were placed in dump scows, towed to the basin above the lock by tugboat *General Warren*, and dumped for use in repairs of the banks around the basin, and 1,350 yards were dumped in deep water in Little Lake Buttes des Morts. The dredge then moved into the basin above the lock and removed about 25 cubic yards of stone from the canal banks, and placed 4,669 cubic yards of dredged material to widen and raise the banks around the basin. Of the material placed on the banks, all but 1,800 cubic yards were dumped into the basin some years ago for the purpose of strengthening the banks, but had never been placed on them. This material, together with that brought from the channel below the lock, has increased the height of the banks around the basin an average of about 12 inches, while the width of the banks has been increased about 10 feet. This work was completed on August 13, 1893, and the dredge was employed until August 20 at work in connection with repairs of canal banks at Rapide Croche (loading large pieces of stone from canal banks at Menasha on to scows for use in riprapping the river slope of the canal banks), after which she was towed to the Upper Fox.

REPAIRS OF BOATS AND DREDGES.

Quarter boat No. 1.—The cabin was removed from the old to a new hull and towed from Kaukauna to Berlin Lock. Thirty-seven broken lights of glass in the cabin windows were replaced by new glass.

Pile-driver.—New platform sills, leaders and ladder were made, bolted together, placed on a scow, and a spud made and fitted to scow. The boiler was loaded on a scow at Berlin and the scow towed to Oshkosh by tugboat *Fox*, and the boiler repaired by putting in 32 new flues. The boiler was then returned to Berlin.

Eighty-foot flat scows.—The two 80-foot flat scows were towed to Oshkosh in May 1893, hauled out, and blocked up for repairs. The old sides, deck, and deck beams were removed and replaced by new material, and the decks, sides, bottoms, and ends recalked, completing the repairs on July 22, 1893.

Steam tug Fox.—A new gas-pipe rudderpost was made and the blade and irons fitted to same, and the rudder secured in place; the piston rods of the main engines were straightened and trued up; the throttle valve put in good repair and changed so as to work the reverse way from what it originally did; 4 sight-feed oil cups were fitted and placed so as to oil the slides of the engines; 4 1¼-inch holes were drilled into the firebox part of boiler, to facilitate the cleaning of the boiler, and brass plugs were fitted to the holes; new brass followers were made and fitted to the steam pump; new shelves were put in upper dining room and two staterooms; a small side table made for the dining room, and a small cupboard was made for the kitchen; the pilot house was painted one coat inside and out, and the lower cabin one coat outside; the walls of the dining room and the floors of kitchen and dining room of lower cabin, the deck and engine rooms and hull, were painted one coat; the steam pipes and machinery painted, and the name painted on the front and both sides of the pilot house and on the sides of the wheelhouses. The repairs were completed and the boat put in commission on April 14, 1894.

Steam tug Boscobel.—Two new bridge trees were made and secured in place; new fender strakes bolted on outer edge of guards; two wheel beams spliced; both paddle wheels were repaired; the lower ends of 27 studs of wheelhouse, which were badly decayed, were spliced with new material, and the sliding and bulkheads of wheelhouses repaired; 3 new stay braces were made and put on crown sheet of boiler to replace broken ones; the outside of boiler was thoroughly cleaned and re-covered with asbestos; a new core wheel, core-wheel shaft and pinion were made and put in place; the old paddle-wheel shaft taken out and turned off for a new coupling; a new spool put on shaft, and the shaft replaced and lined up. The repairs were completed and the boat put in commission on June 2, 1894.

Steam tug General G. K. Warren.—The boat was laid up for a few days in July, 1893, for repairs, and the crank shaft and boxes for same were taken out, repaired, and replaced, and a new oil cup provided for oiling the shaft. The machinery was put together and the boat put in commission for the season of 1894 on May 1, and the boat run to Oshkosh to have repairs made that could not be done properly at Appleton. The stern bearing was raised up so as to bring the propeller shaft in line; the reversing lever and links of the engine were taken off, the link planed true, and a steel plate fitted to the side of link block; the reversing lever was straightened and secured in place by a new steel pin; the inside of the engine cylinder was smoothed to a true diameter; holes in the coal bunkers were patched with boiler plate; parts of the machinery painted, and the side seams of hull, above water, were recalked, completing the repairs.

Dredge No. 2.—The dredge was towed by the tugboat *General Warren* from Cedars Lock to Appleton Second Lock, for repairs, on May 1, 1894. The dipper was shipped to Chicago, and the 3 dipper teeth repointed with new steel; new boxes for dipper-handle shaft were put on crane, and a new cap made for the box at the upper end of the crane mast; new diagonal braces were placed in crane; the turntable put in good repair; boxes of the endless chain shaft on mast of turntable were rebabbitted; the machinery was cleaned; hoisting and swinging engines connected; steam and water pipes repacked and connected; the boiler washed out; hand and manhole plates of boiler repacked; a new pop safety valve put on boiler; the heater pipes connected, and a water catcher placed under the heater. The repairs were completed and the dredge put in commission May 11, 1894.

Dredge No. 3.—The dipper door was sent to Chicago for repairs. A new steel bottom was put on framework of door and slight repairs made to the doorlatch, etc. The dipper handle was taken down and the top edge dressed to a fair surface and replaced. The throttle valve of the swinging engines was taken to a machine shop and put in good repair; the steam and water pipes were connected; hand and manhole plates of boiler and stuffing box of engines repacked; bleeder pipes and valves changed, and portions of the machinery painted. The skiff and wood scow belonging to the dredge were hauled out and slight repairs made to same. The repairs were completed and the dredge placed in commission on May 3, 1894.

Dredge No. 4.—The starboard end of hoisting-drum shaft was provided with a new brass box; new steel thrust collars and new brass bushings were put in end of drum, and oil cups placed to oil the thrust collars; the old blocks in the friction clutch of hoisting drum were taken out and replaced by new ones of hard maple. A new wrist pin was made for one of the hoisting engines and the boxes of the crank shaft rebabbitted. Hog rods were put on the outside face of the lower arm of the crane, to prevent the springing of the arm sidewise. The machinery was cleaned, put together, and steam-pipe connections made, completing the repairs. The dredge was put in commission May 16, 1894.

Dredge No. 5.—The clam-shell dipper was sent to Chicago for repairs. New lips were made and rivetted to dipper; the four arm lugs were rerivetted; new steel bushings were put in throughout, and the dipper returned to Berlin. New sheaves for closing chains of dipper to run on were put in place; new sheaves were made and placed for hoisting and swinging chains; the old blocks in friction clutch of hoisting drum were replaced with a new set of hard maple ones; new boxes were provided for hoisting and swinging drum shafts; the deck pump was connected with the boiler; the machinery was cleaned and put together, completing the repairs, and the dredge put in commission on May 4, 1894.

Dredge No. 7.—A new lip and four new steel teeth were fitted and rivetted to dipper; four steel pins were made to connect dipper handle to dipper, and two new oil cups, for oiling thrust collars on end of drum, were put in place. The machinery was cleaned and put together, completing the repairs, with the exception of putting new hard maple blocks in the friction clutch of the hoisting drum and a new hawser pipe for the backing chain. The dredge was put in commission on May 11, 1894. After the dredge was put in commission, 1,170 linear feet of open seams in the deck, ends, and sides of hull were recalked with one thread. The calking was done in the morning before the dredge commenced work for the day and in the evening after she had quit work, so as not to delay the dredging.

MISCELLANEOUS.

The tugboat *Fox* was employed in towing dredges on the Upper Fox from place to place, in supplying them with fuel, in towing scows with materials for repairs of locks and dams, and on inspection trips.

The tugboats *General G. K. Warren* and *Boscobel* towed dump scows for dredges Nos. 2, 3, and 4 for the channels at Grignon Rapids and below Combined and Rapide Croche Locks, scow loads of materials for repairs of locks, dams, and canal banks, and on inspection trips.

CONTINGENCIES.

The Cook block, in which the Engineer Office at Oshkosh was located, was burned early in the morning of December 1, 1893, and nearly all the property in the office destroyed. By courtesy of the postmaster, rooms for temporary use were obtained in the Government building at Oshkosh, and upon application to the Department permission of the Secretary of the Treasury was obtained to occupy the rooms until such time as they would be needed for the next session of the U. S. court. The rooms were occupied until May 14, 1894, when a room in the Cook block was made ready, new furniture was purchased and moved in, and office quarters taken up on that date.

Very respectfully, your obedient servant,

SAMUEL WHITNEY,
Assistant Engineer.

Maj. JAMES F. GREGORY,
Corps of Engineers, U. S. A.

OPERATING AND CARE OF CANALS AND OTHER WORKS OF NAVIGATION, APPLIED TO FOX RIVER, WISCONSIN (SECTION 4 OF RIVER AND HARBOR ACT OF JULY 5, 1884).

Detailed statement of expenditures for fiscal year ending June 30, 1894, with itemized statement of expenses attached, as required by the above act of July 5, 1884.

Character of work, etc.	Item of expense.	Amount.	Total.
Repairs of De Pere Lock	Materials	$66.97	
Do	Labor	100.75	$167.72
Repairs of De Pere Dam	Materials	336.29	
Do	Labor and transportation	580.12	916.41
Repairs of Little Kaukauna Lock	Materials	15.86	
Do	Labor	6.00	21.86
Repairs of Little Kaukauna Dam	Materials	271.99	
Do	Labor and transportation	662.95	934.94
Repairs of Rapide Croche Dam	Materials	2,761.55	
Do	Labor and transportation	2,090.49	4,852.04
Repairs of canal banks, Rapide Croche	Labor	756.53	756.53
Repairs of Kaukauna, Fifth Lock	do	15.25	15.25
Repairs of lock house at Kaukauna, Fifth Lock.	Materials	142.16	
Do	Labor	69.92	212.08
Repairs of Kankauna, Fourth Lock	do	3.00	3.00
Repairs of Kaukauna, Third Lock	Materials	9.85	
Do	Labor	2.50	12 35
Repairs of Kaukauna, Second Lock	Materials	2.94	
Do	Labor	2.33	5.27
Repairs of lock house at Kaukauna, Second Lock.	Pump for well	5.50	5.50
Repairs of Kaukauna, First Lock	Materials	18.00	
Do	Labor	15.75	33.75
Repairs of warehouse at Kaukauna, First Lock.	Materials	19.53	19.58
Repairs of Kankauna Dam	do	34.01	
Do	Labor and transportation	209.62	243.63
Repairs of Little Chute Canal, Third Level.	Labor	209.65	209.65
Repairs of Little Chnte, Second Lock	Materials	711.35	
Do	Labor and transportation	849.97	1,561.32
Repairs of Little Chute, First Lock	Materials	1,144.92	
Do	Labor and transportation	1,225.38	2,370.30
Repairs of lock house at Cedars Lock	Materials	14.75	14.75
Repairs of Appleton, Fourth Lock	do	1.86	
Do	Labor	3.00	4.86
Repairs of lock house at Appleton, Fourth Lock.	Materials	4.47	4.47
Repairs of Appleton, Third Lock	do	10.99	
Do	Labor	34.00	44.99
Repairs of Appleton, Second Lock	Materials	13.67	
Do	Labor	8.62	22.29
Repairs of Appleton, First Lock	Materials	400.09	
Do	Labor and transportation	437.81	837.90
Repairs of Appleton, Lower Dam	Materials	38.70	38.70
Repairs of Appleton, Upper Dam	do	107.15	
Do	Labor	83.42	190.57
Repairs of Menasha Lock	Materials	2.55	2.55
Repairs of Eureka Dam	do	9.40	
Do	Labor	31.81	41.21
Repairs of lock house at Berlin Lock	Materials	67.00	
Do	Labor	42.00	109.00
Repairs of lock house at Princeton Lock	Materials	45.14	
Do	Labor	53.50	98.64

OPERATING AND CARE OF CANALS, ETC.—continued.

Detailed statement of expenditures for fiscal year ending June 30, 1894, etc.—Continued.

Character of work, etc.	Item of expense.	Amount.	Total
General repairs of locks, dams, and canal banks.	Labor	$200.00	$200.00
Dredging bars, Lower Fox	Fuel, supplies, etc	418.11	
Do	Labor	955.23	
			1 373 34
Dredging bars, Upper Fox	Fuel, supplies, etc	1,275.34	
Do	Labor	3,262.25	
			4.537.59
Repairs of boats and dredges	Rent of boat yard at Oshkosh	100.00	
Do	Repairs of dredge No. 2	530.20	
Do	Repairs of dredge No. 3	136.96	
Do	Repairs of dredge No. 4	259.24	
Do	Repairs of dredge No. 5	660.24	
Do	Repairs of dredge No. 7	470.53	
Do	Repairs of steamer Fox	326 15	
Do	Repairs of steamer Gen. Warren	178 26	
Do	Repairs of steamer Boscobel	716 04	
Do	Repairs of pile-driver	290.51	
Do	Repairs of 80-foot flat scows Nos. 1 and 2.	514 10	
Do	Repairs of quarter boat No. 1	54.37	
			4,236 64
Repairs of barge Princeton	Labor	59.37	59.37
Repairs of 80-foot flat scow No. 1	do	349.51	349.51
Maintenance of navigation	Lock-tenders' services	6,899.98	
Do	Gauge-keepers' services	160.00	
Do	Superintendence	173.75	
			7,233.73
Care of works and property	Watchmen, labor and transportation.	1,179.48	
Do	Traveling expenses of assistant engineers, overseers, etc.	230 51	
Do	Rent of storehouse and lock house, Appleton, Wis.	135 00	
Do	Repairs of tools and machinery	151.58	
			1,696.57
Contingencies	Salaries of assistant engineers, clerks, etc.	2,800.00	
Do	Rent of office at Oshkosh, Wis	269.97	
Do	Stationery	200.91	
Do	Mileage of officers	132.96	
Do	Drawing instruments for office at Oshkosh, Wis.	64.37	
Do	Blue-prints	49.77	
Do	Telegrams	2.45	
			3,520.43
Total			36,958.24

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, indefinite, act of July 5, 1884, applied to Fox River, Wisconsin.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1893.				
July 3	1	Samuel Whitney	Traveling expenses	$9.24
3	2	C. A. Peck	Sheets, etc	21.20
5	3	Hired men	Services, June, 1893	1,517.52
14	4	Swain & Tate Co	Rules for lock-tenders, etc	5.50
31	5	Fred. J. Anger	Services	55.00
31	6	John M. Paige	do	35.00
31	7	Alexander Sims	do	35.00
31	8	John Baeten	do	25.00
31	9	George T. Allanson	do	30.00
31	10	George Gifford	do	25.00
31	11	Gabriel Wick	do	25.00
31	12	John A. Banker	do	25.00
31	13	Gottlieb Jahnke	do	25.00
31	14	Jerry Parkinson	do	25.00
31	15	John Lewis	do	25.00
31	16	Richard E. Rice	do	25.00
31	17	James Clear	do	30.00
31	18	M. H. Neumann	do	10.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1893.				
Aug. 4	1	Swain & Tate Co	Books	$23.00
7	2	Hired men	Services, July, 1893	1,927.16
7	3	Henry A. Foster	Oil	1.00
7	4	Appleton Machine Co	Nuts, etc	27.69
7	5	John Tracy	Wood	245.37
7	6	J. C. Koelsch	Soap, etc	10.63
7	7	Jas. Gillingham & Son	Lumber, etc	15.22
7	8	Hay Hardware Co	Iron, etc	15.68
7	9	J. A. Barnes	Iron shims, etc	17.80
7	10	Conlee Lumber Co	Lumber	31.20
7	11	Stroud & Thompson	Oakum, etc	53.98
7	12	H. Stedman	Coal	114.41
7	13	Priest & Garrow	Wood	364.80
7	14	Stephen Vedder	Depositing dredged material	7.00
7	15	E. W. Moran	Soap, etc	6.51
7	16	A. W. Priest	Coal	103.06
7	17	Gerry Lumber Co	Lumber	2.94
8	18	Samuel Whitney	Services	200.00
8	19	......do	Traveling expenses	17.58
8	20	Elwin Bauter	......do	3.77
25	21	Martin Conner	Services	8.25
31	22	A. Ross Houston	......do	200.00
31	23	John M. Paige	......do	35.00
31	24	Alexander Sims	......do	35.00
31	25	John Baeten	......do	25.00
31	26	George T. Allanson	......do	30.00
31	27	George Gifford	......do	25.00
31	28	Gabriel Wick	......do	25.00
31	29	John A. Banker	......do	25.00
31	30	Gottlieb Jahnke	......do	25.00
31	31	Jerry Parkinson	......do	25.00
31	32	John Lewis	......do	25.00
31	33	Richard E. Rice	......do	25.00
31	34	James Clear	......do	30.00
31	35	M. H. Neumann	......do	10.00
31	36	Rather & Schaeuble	Canthook handles, etc	3.40
31	37	Butler Bros	Pump, etc	7.00
31	38	Appleton Machine Co	Driftbolts, etc	14.36
31	39	J. C. Koelsch	Oil	1.25
31	40	Battis Bros	Steel, etc	5.98
31	41	Orville Beach	Rent of land	25.00
31	42	Conlee Lumber Co	Lumber	1,490.37
31	43	John W. Slater	White lead, etc	3.20
31	44	H. Miner	Wall paper, etc	9.82
31	45	C. A. Peck	Tin, etc	26.10
31	46	H. Stedman	Shingles, etc	101.85
31	47	Peter Littlechild	Depositing dredged material	9.10
31	48	Swain & Tate Co	Paper	5.25
31	49	Samuel Whitney	Services	200.00
Sept. 2	1	F. Hurlbut	Wood	56.00
2	2	Elwin Bauter	Traveling expenses	6.49
2	3	Samuel Whitney	......do	20.62
4	4	Jones & Laughlins, Limited	Drift bolts, etc	274.18
5	5	Hired men	Services, August, 1893	2,501.88
7	6	Henry Soper	Services	15.00
30	7	Fred. J. Anger	......do	55.00
30	8	Samuel Whitney	......do	200.00
30	9	E. O. Hoffmann	......do	150.00
30	10	John M. Paige	......do	35.00
30	11	Alexander Sims	......do	35.00
30	12	John Baeten	......do	25.00
30	13	George T. Allanson	......do	30.00
30	14	George Gifford	......do	25.00
30	15	Gabriel Wick	......do	25.00
30	16	John A. Banker	......do	25.00
30	17	Gottlieb Jahnke	......do	25.00
30	18	Jerry Parkinson	......do	25.00
30	19	John Lewis	......do	25.00
30	20	Richard E. Rice	......do	25.00
30	21	James Clear	......do	30.00
30	22	M. H. Neumann	......do	10.00
30	23	Rather & Schaeuble	Brooms, etc	1.90
30	24	Butler Bros	Rope	11.76
30	25	Schlafer, Barrett & Teech	Galvanized iron pump, etc	9.54
30	26	Appleton Machine Co	Iron spar rollers, etc	28.02
30	27	A. L. Smith	Hire of house	45.00
30	28	J. A. Barnes	Iron, etc	4.00
30	29	D. P. Sanford	Oil	4.64
30	30	Stroud & Thompson	Cotton waste, etc	11.99

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1893.				
Sept. 30	31	Ossian Cook	Rent of office	$66.00
30	32	Conlee Lumber Co	Lumber	668.38
30	33	Thos. E. Decker	do	3.00
30	34	Niels Johnson	Globe valves, etc	5.09
30	35	do	Injector, etc	53.60
30	36	C. A. Peck	Packing, etc	12.80
30	37	H. Stedman	Coal, etc	68.98
Oct. 3	1	A. W. Priest	Coal	420.65
	2	Fairbanks & Laehn	Patch bolts	11.72
4	3	Hired men	Services, September, 1893	2,760 00
6	4	Des Forges & Co	Stationery	24.00
17	5	William Carrington	Services	19.50
24	6	Swain & Tait Co	Heading vouchers	3.50
Nov. 3	1	Samuel Whitney	Services	200.00
3	2	John M. Paige	do	35.00
3	3	Alexander Sims	do	35.00
3	4	John Baeten	do	25.00
3	5	George T. Allanson	do	30.00
2	6	George Gifford	do	25.00
3	7	Gabriel Wick	do	25.00
3	8	John A Banker	do	25.00
3	9	Gottlieb Jahnke	do	25.00
3	10	Jerry Parkinson	do	25.00
3	11	John Lewis	do	25.00
3	12	Richard E. Rice	do	25.00
3	13	James Clear	do	30.00
3	14	M. H. Neumann	do	10.00
3	15	Hired men	Services, October, 1893	228.15
3	16	Butler Bros	Iron, etc	66.19
3	17	Appleton Machine Co	Steel bolt, etc	1.55
3	18	H. A. Foster	Lead, etc	14.75
3	19	Gerry Lumber Co	Lumber, etc	120.31
3	20	J. F. Joslyn	Iron, etc	2.55
3	21	George Rounds	Depositing dredged material	17 23
3	22	C. A. Peck	Glass, etc	3.98
3	23	Hiram Stedman	Lumber, etc	4.25
3	24	Niels Johnson	Pipe, etc	10.93
3	25	Priest & Gorrow	Wood	187.68
4	26	Hired men	Services, October, 1893	1,557.29
28	27	Fred. J. Anger	Services	36.67
30	28	Samuel Whitney	do	200.00
30	29	John M. Paige	do	35.00
30	30	Alexander Sims	do	35.00
30	31	John Baeten	do	25.00
30	32	George T. Allanson	do	30.00
30	33	George Gifford	do	25.00
30	34	Gabriel Wick	do	25.00
30	35	John A. Banker	do	25.00
30	36	Gottlieb Jahnke	do	25.00
30	37	Jerry Parkinson	do	25.00
30	38	John Lewis	do	25.00
30	39	Richard E. Rice	do	25.00
30	40	James Clear	do	30.00
30	41	M. H. Neumann	do	10.00
36	42	G. G. Pratsch	Boat spikes	11.50
30	43	De Pere Lumber and Fuel Co	Lumber	92.77
30	44	Thos. Jackson	Driftbolts, etc	26.89
30	45	Charles W. Day	Lumber	71.91
30	46	Butler Bros	Oil, etc	3.95
30	47	Gerry Lumber Co	Lumber	4.47
30	48	Appleton Machine Co	Iron castings, etc	5.56
30	49	Orville Beach	Rent of land	25.00
30	50	C. A. Peck	Tins, etc	17.59
30	51	John Jansen	Lumber	17.25
Dec. 4	1	Samuel Whitney	Traveling expenses	17.03
4	2	Charles M. Cole	do	11.21
6	3	Hired men	Services, November, 1893	942.36
7	4	F. E. Caldwell	Traveling expenses	6.55
7	5	Des Forges & Co	Stationery	22.60
9	6	Western Union Telegraph Co	Telegrams	2.45
13	7	Swain & Tate Co	Time reports	9.50
16	8	Maj. James F. Gregory	Mileage	12.80
28	9	M. J. Schmitt & Co	Blue prints	30.75
30	10	Thos. Jackson	Driftbolts	17.25
30	11	De Pere Lumber and Fuel Co	Lumber	181.94
30	12	Butler Bros	Galvanized iron pump	4.50
30	13	J. A. Barnes	Iron castings, etc	.75
30	14	Stroud & Thompson	Camel-hair brush	.83

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1893.				
Dec. 30	15	Hay Hardware Co	Fire screens	$4.25
30	16	Ossian Cook	Rent of office	44.00
31	17	A. Ross Houston	Services	200.00
31	18	Helen P. Gilman	do	20.00
31	19	Samuel Whitney	do	200.00
31	20	John M. Paige	do	35.00
31	21	Alexander Sims	do	35.00
31	22	John Baeten	do	25.00
31	23	George T. Allanson	do	30.00
31	24	George Gifford	do	25.00
31	25	Gabriel Wick	do	25.00
31	26	John A. Banker	do	25.00
31	27	Gottlieb Jahnke	do	25.00
31	28	Jerry Parkinson	do	25.00
31	29	John Lewis	do	25.00
31	30	Richard E. Rice	do	25.00
31	31	James Clear	do	30.00
1894.				
Jan. 3	1	Hired men	Services, December, 1893	566.50
4	2	F. E. Caldwell	Traveling expenses	1.82
4	3	Charles Wheaton	Plastering, etc	16.80
4	4	A. L. Smith	Hire of house	45.00
4	5	Eugene Dietzgen Co	Tracing cloth	8.28
4	6	Badger Typewriter and Stationery Co	Repairs of typewriter, etc	52.75
4	7	Des Forges & Co	Stationery	36.00
6	8	Charles M. Cole	Traveling expenses	10.67
15	9	Maj. James F. Gregory	Mileage	19.52
24	10	Eugene Dietzgen Co	Instruments, etc	64.37
31	11	Helen P. Gilman	Services	40.00
31	12	Samuel Whitney	do	200.00
31	13	John M. Paige	do	35.00
31	14	Alexander Sims	do	35.00
31	15	John Baeten	do	25.00
31	16	John T. Allanson	do	30.00
31	17	George Gifford	do	25.00
31	18	Gabriel Wick	do	25.00
31	19	John A. Banker	do	25.00
31	20	Gottlieb Jahnke	do	25.00
31	21	Jerry Parkinson	do	25.00
31	22	John Lewis	do	25.00
31	23	Richard E. Rice	do	25.00
31	24	James Clear	do	30.00
Feb. 3	1	F. E. Caldwell	Traveling expenses	16.40
3	2	Elwin Bauter	do	2.45
5	3	Hired men	Services, January, 1894	580.73
7	4	Charles M. Cole	Traveling expenses	15.00
7	5	L. M. Mann	do	10.82
14	6	A. Ross Houston	do	7.34
14	7	Swain & Tate Co	Transmittals	8.00
16	8	Lieut. C. H. McKinstry	Mileage	17.44
24	9	H. H. West Co	Book, etc	9.25
26	10	Lieut. C. H. McKinstry	Mileage	17.12
28	11	Butler Bros	Nails, etc	3.30
28	12	John M. Hurn	Waste baskets, etc	2.40
28	13	Orville Beach	Rent of land	25.00
28	14	C. A. Peck	Galvanized iron pump	3.75
28	15	Helen P. Gilman	Services	40.00
28	16	Samuel Whitney	do	200.00
28	17	John M. Paige	do	35.00
28	18	Alexander Sims	do	35.00
28	19	John Baeten	do	25.00
28	20	George T. Allanson	do	30.00
28	21	George Gifford	do	25.00
28	22	Gabriel Wick	do	25.00
28	23	John A. Banker	do	25.00
28	24	Gottlieb Jahnke	do	25.00
28	25	Jerry Parkinson	do	25.00
28	26	John Lewis	do	25.00
28	27	Richard E. Rice	do	25.00
28	28	James Clear	do	30.00
Mar. 2	1	Eugene Dietzgen Co	Drawing paper	7.97
2	2	J. V. Beyer	Labor	5.60
2	3	F. E. Caldwell	Traveling expenses	5.96
3	4	Hired men	Services, February, 1894	947.37
3	5	Elwin Bauter	Traveling expenses	8.11
5	6	Appleton Machine Co	Anchor bolts, etc	47.79
5	7	Charles W. Day	Oak lumber	706.02
5	8	do	Pine lumber	616.99

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1894.				
Mar. 5	9	Charles W. Day	Pine lumber	$591.46
12	10	Swain & Tate Co	Reports of operations, etc	19.50
14	11	do	Transmittals of checks	4.26
16	12	Lieut. C. H. McKinstry	Mileage	13.44
23	13	Maj. James F. Gregory	do	12.80
24	14	Wyckoff, Seamans & Benedict	Paper, etc	10.15
30	15	Swain & Tate Co	Returns of navigation, etc	6.75
31	16	Helen P. Gilman	Services	40.00
31	17	Samuel Whitney	do	200.00
31	18	John M. Paige	do	35.00
31	19	Alexander Sims	do	35.00
31	20	John Baeten	do	25.00
31	21	George T. Allanson	do	30.00
31	22	George Gifford	do	25.00
31	23	Gabriel Wick	do	25.00
31	24	John A. Banker	do	25.00
31	25	Gottlieb Jahnke	do	25.00
31	26	Jerry Parkinson	do	25.00
31	27	John Lewis	do	25.00
31	28	Richard E. Rice	do	25.00
31	29	James Clear	do	30.00
31	30	John Jansen	Hemlock lumber	22.32
31	31	Appleton Machine Co	Set screws, etc	8.84
31	32	McKenzie & Crawford	Coal	8.00
Apr. 4	1	Hired men	Services, March, 1894	1,281.96
4	2	A. L. Smith	Hire of house	45.00
4	3	Elwin Bauter	Traveling expenses	2.46
4	4	F. E. Caldwell	do	1.57
7	5	Jones & Laughlins, Limited	Bolts, etc	231.64
7	6	Charles M. Cole	Traveling expenses	12.07
11	7	Lieut. C. H. McKinstry	Mileage	14.24
23	8	do	do	12.80
25	9	Herman Voss	Binding records, etc	1.50
30	10	Helen P. Gilman	Services	40.00
30	11	Samuel Whitney	do	200.00
30	12	John M. Paige	do	35.00
30	13	Alexander Sims	do	35.00
30	14	John Baeten	do	25.00
30	15	George T. Allanson	do	30.00
30	16	George Gifford	do	25.00
30	17	Gabriel Wick	do	25.00
30	18	John A. Banker	do	25.00
30	19	Gottlieb Jahnke	do	25.00
30	20	Jerry Parkinson	do	25.00
30	21	John Lewis	do	25.00
30	22	Richard E. Rice	do	25.00
30	23	James Clear	do	30.00
30	24	John Jansen	Oak lumber	3.84
30	25	Schlafer Barrett & Tesch	Nails, etc	1.91
30	26	Ramsay & Jones	Pine lumber	8.94
30	27	Appleton Machine Co	Iron, etc	11.99
30	28	Manser & Renner	Oak lumber, etc	16.09
30	29	A. Sanford Logging Tool Co	Pike poles, etc	6.90
30	30	Stroud & Thompson	White lead, etc	8.32
30	31	John F. W. Decker	Slop jars, etc	17.06
30	32	McKenzie & Crawford	Coal, etc	20.95
30	33	Hay Hardware Co	Rope, etc	29.39
30	34	Battis Bros	Flues, etc	56.73
May 2	1	Hired men	Services, April, 1894	1,758.88
2	2	Excelsior Iron Works	Steel, etc	141.30
7	3	Jones & Laughlins, Limited	Chain	98.92
14	4	M. J. Schmitt & Co	Blueprints, etc	19.02
14	5	L. M. Mann	Traveling expenses	9.86
14	6	Swain & Tate Co	Heading vouchers	4.00
21	7	Lieut. C. H. McKinstry	Mileage	12.80
21	8	L. M. Mann	Traveling expenses	21.95
31	9	Fred. J. Anger	Services	55.00
31	10	Samuel Whitney	do	200.00
31	11	John M. Paige	do	35.00
31	12	Alexander Sims	do	35.00
31	13	John Baeten	do	25.00
31	14	George T. Allanson	do	80.00
31	15	George Gifford	do	25.00
31	16	Gabriel Wick	do	25.00
31	17	John A. Banker	do	25.00
31	18	Gottlieb Jahnke	do	25.00
31	19	Jerry Parkinson	do	25.00
31	20	John Lewis	do	25.00

Itemized statement of expenses made from appropriation for operating and care of canals and other works of navigation, etc.—Continued.

Date.	No. of voucher.	To whom paid.	For what paid.	Amount.
1894.				
May 31	21	Richard E. Rice	Services	$25.00
31	22	James Clear	do	30.00
31	23	John Jansen	Lumber	10.05
31	24	Schlafer, Barrett & Tesch	Paint, oil, etc	12.06
31	25	Appleton Machine Co	Spar rollers, etc	29.69
31	26	do	Valves, iron, etc	113.07
31	27	Fairbanks & Swallow	Chain, etc	60.35
31	28	Gerry Lumber Co	Lumber	69.65
31	29	Williamson & Libbey Lumber Co	do	2.90
31	30	E. G. Tulledge	Window shades	3.00
31	31	John F. W. Decker	Cuspidors, etc	5.92
31	32	Hay Hardware Co	Floor brush, etc	5.53
31	33	do	Rope, etc	22.69
31	34	H. C. Johnson & Son	Window awnings	9.00
31	35	Strond & Thompson	Cotton waste, etc	10.94
31	36	McKenzie & Crawford	Coal	16.47
31	37	The Soper Furniture Co	Chairs, etc	17.50
31	38	J. A. Barnes	Steel, etc	19.20
31	39	Battis Bros	Sheet steel, etc	23.25
31	40	Orville Beach	Rent of land	25.00
31	41	D. P. Sandford	Oil and grease	37.74
31	42	Robert Brand & Sons	Office desks, etc	75.85
31	43	C. A. Peck	Oil, iron, etc	10.44
31	44	Hiram Stedman	Coal	17.43
31	45	Chas. S. Morris	do	19.87
31	46	J. W. Slater	Boiled linseed oil	22.47
31	47	Niels Johnson	Lubricators, etc	60.63
31	48	do	Friction blocks, etc	108.03
31	49	do	Bushings, etc	271.02
31	50	John Featherstone's Sons	Steel, etc	212.83
June 5	1	Hired men	Services, May, 1894	1,298.83
7	2	Samuel Whitney	Traveling expenses	4.21
7	3	Elwin Bauter	do	7.33
7	4	Jones & Laughlins, Limited	Chain	72.93
7	5	Niels Johnson	Injector, etc	170.88
7	6	Harry Loy	Services	3.00
8	7	Sam Stern	Rent of office	22.33
12	8	Swain & Tate Co	Report of operations, etc	15.00
28	9	Thos. Jackson	Key bolts, etc	1.00
28	10	Charles W. Day	Lumber	127.80
28	11	Schlafer, Barrett & Tesch	Nails	3.07
28	12	H. A. Foster	Paint, oil, etc	44.25
28	13	Appleton Machine Co	Iron core wheel, etc	370.21
28	14	Strond & Thompson	Oakum, etc	6.40
28	15	McKenzie & Crawford	Coal	12.18
28	16	Hay Hardware Co	Rope	17.73
28	17	Sam Stern	Rent of office	20.84
28	18	S. E. McPartlin	Covering boiler, etc	64.17
28	19	C. E. Tirnann	Depositing dredged material	6.13
28	20	John Andre Co	Bed springs	6.00
28	21	Chas. S. Morris	Coal	12.62
28	22	Priest & Gorrow	Wood	265.69
29	23	Battis Bros	Steel plate, etc	13.44
29	24	C. A. Peck	Lye, iron, etc	20.95
29	25	Niels Johnson	Iron castings, etc	85.62
30	26	Fred. J. Anger	Services	55.00
30	27	Samuel Whitney	do	200.00
30	28	John M. Paige	do	35.00
30	29	Alexander Sims	do	35.00
30	30	John Baeten	do	25.00
30	31	George T. Allanson	do	30.00
30	32	George Gifford	do	25.00
30	33	Gabriel Wick	do	25.00
30	34	John A. Banker	do	25.00
30	35	Gottlieb Jahnke	do	25.00
30	36	Jerry Parkinson	do	25.00
30	37	John Lewis	do	25.00
30	38	Richard E. Rice	do	25.00
30	39	James Clear	do	30.00
30	40	Wm. Peterman & Sons	Chisels, etc	3.30
		Total		36,958.24

J J 24.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Under date of November 17, 1893, a communication from the board of public works of Racine, Wis., was received requesting the removal, under the provisions of section 8 of river and harbor act of September 19, 1890, of two sunken vessels, which were alleged to be obstructions to navigation in the Root River at that place.

Upon investigation it was found that one of the vessels—schooner *G. Barber*—was afloat and should be removed by the city authorities.

The other vessel—schooner *Mount Vernon*—was found sunken in the river near the head of navigation, above Meade street, with her rail just above water. It was an obstruction to navigation, and its removal by the United States under section 8 of river and harbor act of September 19, 1890, was recommended. The recommendation was approved by the Chief of Engineers, and under date of December 11, 1893, an allotment was made of $300 from the permanent indefinite appropriation for removing sunken vessels or craft obstructing or endangering navigation, act of June 14, 1880, to pay the expenses of said work.

After advertisement for proposals a contract was entered into with Mr. Harris W. Baker, of Detroit, Mich., for doing this work at a cost of $199. Under this contract the wreck was floated and hauled out on the bank of the river on March 5, 1894. After its removal authority was requested to sell it at public auction, which was given by the Chief of Engineers, and on April 5, 1894, after due advertisement by posters and circular letters, it was sold to the highest bidder. The net proceeds of the sale, $15.32, was covered into the Treasury to the credit of the appropriation for "removing sunken vessels or craft obstructing or endangering navigation, indefinite."

The total amount expended during the year upon removal of wrecks is $210.54.

Abstract of proposals for removal of wreck of schooner Mount Vernon from Root River at Racine, Wis., received in response to advertisement dated January 23, 1894, and opened February 26, 1894, by Maj. James F. Gregory, Corps of Engineers.

No.	Name and residence of bidder.	Price.
1	Edward Gillen, Racine, Wis	$199
2	Samuel O. Dixon, Racine, Wis	210
3	Harris W. Baker, Detroit, Mich	199

Amount allotted for this work, $300.

With the approval of the Chief of Engineers, a contract was entered into March 5, 1894, with Harris W. Baker for this work.

J J 25.

ESTABLISHMENT OF HARBOR LINES IN OCONTO HARBOR, WISCONSIN.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wis., September 14, 1893.

GENERAL: Respectfully referring to letter, office of the Chief of Engineers, June 26, 1893, establishing certain harbor lines at Oconto

Harbor,* Wisconsin, I have the honor to report that in laying down the lines upon the ground (after an accurate survey) it is found that lines slightly divergent from the approved lines approximate more nearly to the natural river bank and are in every way better. I inclose a tracing† on which is shown in blue the lines as approved and in red the better lines. The stations marked in red, A, B, C, and D, are marked by driven gas pipes two inches in diameter, which are surrounded by piles of stones.

I have therefore to recommend that harbor lines be established as shown in red upon this tracing.

The description is as follows:

(The general course of the south harbor pier is N. 54° 21′ 30″ E., or S. 54° 21′ 30″ W.)

Commencing at a point (A) which is on the shore of Green Bay and upon a line which is parallel to and 250 feet from the channel face of the south harbor pier, thence S. 54° 21′ 30″ W. 1,516 feet to the intersection of the north bank of Oconto River (B), thence S. 76° 44′ W. 753 feet (C), thence S. 52° 37′ 20″ W. 3,243 feet (D), thence up the Oconto River on the same course 1,000 feet to a point opposite the southeast corner of Spies's mill.

Very respectfully, your obedient servant,

JAMES F. GREGORY,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. O. M. Poe, Corps of Engineers, Division Engineer, Northwest Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., September 19, 1893.

Respectfully forwarded to the office of the Chief of Engineers, approved and recommended.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 23, 1893.

Respectfully returned to Maj. Gregory, with request for further information in explanation of his reasons for recommending the extension of the proposed new harbor line beyond the point marked "D" on the course indicated.

The lines now proposed would seem to unnecessarily reduce the width of the river above the point marked "D."

To be returned through the Division Engineer.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

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* For harbor lines in Oconto Harbor, established June 23, 1893, see Annual Report Chief of Engineers, 1893, p. 2784.

† Not printed.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Milwaukee, Wis., September 25, 1893.

Respectfully returned to the Chief of Engineers, U. S. Army, through the Division Engineer.

The extension of the proposed harbor line beyond the point "D" was recommended in order to make an easier curve should the harbor line be in future extended up the river, and because the river is wider at Spies' Mill than at several points below it. A blue print is forwarded, in separate roll, on which is shown the part of the river above Spies' Mill as far as the bridge at Oconto.

The harbor line, however, may very well terminate for the present at a point 300 feet, instead of 1,000 feet, beyond "D" on the course from "C" to "D," as the proposed docks and slips are all to be located down the river from the point "D".

The inclosure (tracing) is returned.

JAMES F. GREGORY,
Major of Engineers.

[Fourth indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., September 27, 1893.

Respectfully forwarded to the office of the Chief of Engineers.

O. M. POE,
Colonel, Corps of Engineers, etc.,
Division Engineer, Northwest Division.

[Fifth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 29, 1893.

Respectfully submitted to the Secretary of War.

Under date of June 23, 1893, harbor lines were established by the Secretary of War for Oconto Harbor, Wisconsin. Maj. James F. Gregory, Corps of Engineers, the district officer, states that in laying down the lines upon the ground, after an accurate survey, it was found that lines slightly divergent from the approved lines approximate more nearly to the natural river bank and are in every way better. He accordingly submits the accompanying tracing, on which is shown in blue the approved lines, and in red the better lines.

Inviting attention to the within report and to the indorsements hereon, it is recommended that the harbor lines shown by a full red line on the accompanying tracing, and described as follows: Commencing at the point "A," which is on the shore of Green Bay, and upon a line which is parallel to and 250 feet from the channel face of the south harbor pier; thence S. 54° 21′ 30″ W. 1,516 feet to the intersection of the north bank of Oconto River (B); thence S. 76° 44′ W. 753 feet (C); thence S. 52° 37′ 20″ W., 3,234 feet (D); thence up the Oconto River, on the same course, 300 feet to a point marked E, be approved, and that the Secretary place his approval both on this paper and upon the tracing.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Sixth indorsement.]

WAR DEPARTMENT, *October 2, 1893.*

Approved.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX K K.

IMPROVEMENT OF CHICAGO AND CALUMET HARBORS AND ILLINOIS RIVER, ILLINOIS, AND CALUMET RIVER, ILLINOIS AND INDIANA; ILLINOIS AND MISSISSIPPI CANAL.

REPORT OF CAPT. W. L. MARSHALL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Chicago Harbor, Illinois.
2. Calumet Harbor, Illinois.
3. Calumet River, Illinois and Indiana.
4. Illinois River, Illinois.
5. Operating and care of La Grange and Kampsville locks and dams, Illinois River.
6. Illinois and Mississippi Canal, Illinois.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., July 20, 1894.

GENERAL: I have the honor to transmit herewith annual reports upon the works in my charge for the fiscal year ending June 30, 1894.

* * * * * * *

Very respectfully, your obedient servant,
W. L. MARSHALL,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

K K 1.

IMPROVEMENT OF CHICAGO HARBOR, ILLINOIS.

The present project was adopted in 1870 and modified in 1878, and contemplates:

(*a*) The formation of an outer harbor or basin by inclosing a portion of Lake Michigan just south of and adjoining the entrance to the river, for the purpose of increasing the harbor facilities of Chicago and to give relief to the overcrowded river.

(*b*) The construction of an exterior breakwater of crib work filled with stone outside the outer harbor and north of the entrance to

Chicago River, in deep water, to shelter the entrance to Chicago River (which constitutes the inner harbor of Chicago) and the outer harbor from northerly storms, and to form a sheltered area for harbor of refuge at the southern end of Lake Michigan.

In addition to this project the entrance to Chicago River, which is protected by piers built by the United States, is to be maintained, both piers and channel.

CONDITION OF THE WORK JUNE 30, 1894.

Outer basin.—This basin, lying south and east of the present mouth of Chicago River, covers about 455 acres in area. A dock and wharf line was established by Special Order, Corps of Engineers, No. 108, August 3, 1871, and adopted and extended upon the recommendation of a board of engineers, by the Secretary of War, September 22, 1890.

This dock line is about 1,300 feet east of the present shore line and nearly parallel to and 2,000 feet distant from the easterly breakwater, and extends throughout the harbor from north to south.

Between the dock line and breakwater an area of 270 acres is included, which the original project contemplated dredging to 16 feet in depth where deficient. The area between dock line and shore is reserved for slips and docks.

A portion of the area of the outer basin seaward of the dock line has been dredged by the United States to 16 feet depth. But for several years dredging has been discontinued because this outer harbor has never been utilized for the purposes for which constructed, on account of the litigation over riparian ownership and rights and titles to submerged lands in the harbor. This litigation is now ended and the ownership to submerged lands and riparian rights decided to be practically in the city of Chicago. The disposition of this property has not yet been determined, and it is not advisable that further expenditures be made for dredging the basin to greater depth until its ultimate uses become apparent.

It is now under consideration by the city authorities to fill in the area shoreward of the dock line for a public park. There seems little reason to expect that this basin will ever be used for commercial purposes, or for other than anchorage grounds for pleasure boats and Government craft.

To complete this basin in accordance with the original design to a depth of 16 feet below United States harbor datum, which is 1 foot above the low-water mark of 1847, requires dredging to the amount estimated in 1887 at 267,000 cubic yards, which amount has since that date been considerably increased by subsequent deposits and drift.

Should the basin be utilized by the construction of docks and piers, or should the city of Chicago fill in the area shoreward of the dock line for park purposes this material will be needed for filling. In any event it is not now advisable to expend money in further dredging.

The piers inclosing this basin have been completed for years, and have within the past four years been put in first-class condition, with the exception of 500 linear feet of superstructure over the easterly end of the southerly breakwater.

There will be but little demand for appropriations for maintenance of these piers and breakwaters for several years, and the work should be restricted to temporary structures of wood and rubble stone until the final disposition of the harbor is determined.

At the close of the last fiscal year work was in progress under contract dated October 28, 1892, with the Wisconsin Dredge and Dock Company, for rebuilding superstructure over 1,225 linear feet of south pier at entrance to Chicago River and over 2,500 linear feet of the easterly and southerly breakwater, outer basin.

This contract was completed during the year, involving in all the placing in the work of 1,031,461 feet, B. M., pine timber and plank; 95,969 pounds drift bolts; 18,070 pounds spikes; 103.29 cords stone; 56 piles, 648 pounds chain, and 576 pounds screw bolts. The report of Assistant Liljencrantz herewith gives details relating to this work.

Exterior breakwater.—This work is situated 1 mile northeast of the entrance to Chicago River, which it covers from northerly storms; it is 5,413 feet in length.

The construction of this breakwater began in 1881 and it was completed in 1890. It is of crib work, 30 feet in width, filled with stone. All except 1,200 feet is placed on the natural bottom in water ranging from 18 to 32 feet in depth. The outer section, 1,200 feet long, is on a stone foundation. This breakwater answers the purpose for which it has been constructed, and its value as forming a safe shelter to vessels during northerly storms, and as a protection to vessels seeking entrance to the inner harbor of Chicago is conceded by all parties engaged in commerce by water at this port.

During the last fiscal year no work has been done upon this breakwater, but it is now in need of immediate attention.

About the 18th of May, 1894, a four days' northeast storm occurred, more furious than has been seen on Lake Michigan in many years. The effect of the storm on the superstructure of the exterior breakwater was disastrous, not only to the old and rotten parts, but also to the newer portion of the work. The damage consisted in the tearing off of the decking, washing out of stone, and breaking away of the inner walls of the cribs at various points. With the exception of the damages to the newer parts of the work, if the injuries be at once repaired before much of the stone be washed out, the carrying away of the decking and inner wall of the superstructure is of slight consequence, as the cost of new superstructure on the old work will be diminished thereby to the extent that the superstructure is removed without cost, but the exposure of the stone filling to the attacks of the sea should be remedied at the earliest possible moment. It is estimated that $75,000 is now needed to repair this work. This estimate is to be increased by 30 per cent if the work can not be done during the present working season.

Entrance to Chicago River.—No work has been done at this part of the harbor during the past year beyond marking the position of the old light-house, which is to be taken away and set up in another place.

Its location is an important geodetic point of the survey of the Great Lakes and has been accurately marked.

It has been customary for the United States to maintain by dredging the channel between the piers at the entrance to Chicago River of sufficient width and depth to accommodate the commerce by water of this port. The last dredging done here was in 1893, and this channel is still sufficient for the purpose.

The largest class of lake vessels can not use the inner harbor of Chicago on account of the obstructions by bridges, tunnels, and docks in Chicago River.

Full information on this subject may be found in the Annual Report of the Chief of Engineers for 1893 p. 2974, *et seq.*

PROPOSED APPLICATION OF THE FUNDS NOW ON HAND AND THOSE REQUIRED FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

These funds are to be applied to the repairs of damages by storm to the exterior breakwater, to the rebuilding of superstructure over the older parts of that structure, and to the rebuilding of superstructure over 500 linear feet of the southerly breakwater, outer basin.

Money statement.

July 1, 1893, balance unexpended	$62,780.59
June 30, 1894, amount expended during fiscal year	35,331.17
July 1, 1894, balance unexpended	27,449.42
July 1, 1894, outstanding liabilities	200.00
July 1, 1894, balance available	27,249.42
Amount (estimated) required for maintenance	100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Expenditures fiscal year 1894.

Rebuilding superstructure southerly breakwater, outer basin:		
Contractors' estimates		$29,016.66
Services of inspector		480.00
Total		29,496.66
1,154 pounds tank steel plate in place, for protecting end of southerly breakwater		103.86
Services of assistant engineer and draftsmen		1,425.00
Services of clerks, messengers, etc		1,250.00
Services of watchmen		1,350.00
Services crew of steam launch		937.00
Services of carpenters and laborers		86.95
Fuel for steam launch, U. S. engineer office, and watchmen		223.00
Repairs, etc., to United States steam launch		159.46
Office supplies, stationery, gas, etc		73.24
Miscellaneous:		
Mileage	$151.84	
Telephone service	31.25	
Rent post-office drawer	4.00	
Street-car tickets	15.00	
Telegrams	5.21	
Notary fees	1.00	
Oil for watchmen's use	1.20	
		209.50
Making permanent mark at site of old light-house		16.50
		35,331.17

Abstract of contracts for improving Chicago Harbor, Illinois, in force during the fiscal year ending June 30, 1893.

Name and address of contractor.	Nature of contract.	Date.	To expire—
Wisconsin Dredge and Dock Co., Manitowoc, Wis.*	Rebuilding superstructure (3,725 linear feet).	Oct. 28, 1892	Dec. 1, 1893

* Contract completed November 16, 1893.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1894.

CAPTAIN: I have the honor to submit herewith a report on operations in Chicago Harbor, Illinois, during the fiscal year ending June 30, 1894.

At the beginning of the year, July 1, 1893, there was one contract in force for work to be done in improvement of this harbor, viz, with the Wisconsin Dredge and Dock Company, of Manitowoc, Wis., for rebuilding the superstructure over the southerly breakwater 2,500 linear feet, 6 courses high, and over the south pier 1,225 linear feet, 4 courses in height, or in all 3,725 linear feet. The contract was dated October 28, 1892, and was to expire on the 1st of December, 1893.

Work under this contract commenced on June 1, 1893, and on the 30th of that month, the close of the fiscal year, superstructure was completed over the southerly breakwater for a distance of 665 linear feet, 295 feet of which—including the so-called angle crib—was 30 feet in width; the balance was 16 feet wide. In this work were secured the following amounts of materials: 179,428 feet, B. M., pine timber and 20,709 pounds of wrought-iron drift bolts, as stated in last years report.

Work under the contract was completed on November 10, 1893, and the contract closed.

Under its terms there were secured in the work the following materials, including those mentioned above as having been secured in place prior to July 1, 1893:

Pine timber	feet, B. M..	774,701
Pine plank	do....	256,760
Wrought-iron drift bolts	pounds..	95,969
Wrought-iron spikes	do....	18,070
Stone	cords..	103,29
Piles, 40 feet long, in clumps		56
Dredge chain, in clumps	pounds..	648
Screw bolts, in clumps	do....	576

The prices governing this contract were unusually low, viz:

Pine timber in the work	per M feet, B. M..	$26.00
Pine plank in the work	do....	18.00
Wrought-iron drift bolts	per pound..	.0245
Wrought-iron screw bolts	do....	.04
Wrought-iron spikes	do....	.0375
Wrought-iron dredge chain	do....	.12
Stone	per cord..	4.50
Piles	each..	11.00

The average cost per linear foot of the different portions of work built under this contract was as follows:

Class of work.	Timber supers.	Stone filling.	6 by 10 inch decking.	Total.
For work 30 feet wide, 6 feet high	$9.95	$4.34	$2.83	$17.12
For work 20 feet wide, 4 feet high	5.85	2.45	1.86	10.16
For work 16 feet wide, 6 feet high	5.68	2.27	1.44	9.39
Clumps of piles, each				89.60

The prices given are in all cases for materials secured in the work, and include, in items for timber superstructure and decking, the bolts and spikes used. Prices are given separately for timber work, decking, etc., that the figures might be used for making estimates and to indicate the relative proportions of cost of the different parts of the work. To make this comparison more useful the items representing cost of stone were made on the supposition that the work was filled to within 6 inches of the top, or level with the upper faces of the cross-ties, though in fact but little *new* stone was found to be required.

A separate table is submitted herewith which gives in detail the distribution of materials in each 100-foot section of the work under this contract, with the total cost of each such section, and so forth.

The total cost of the work was considerably less than estimated, on account of (1) that but very little new stone was required, and (2) that on a portion of the southerly breakwater the lower courses of timber were in much better condition than expected and not in need of renewal.

A deviation from the usual mode of constructing ends of piers was, with your approval, made at the southwesterly end of the southerly breakwater and at the east end of the south pier. The so-called horns, formed by the extension of the side timbers beyond the end wall, were left off, and the necessary connection between end and side walls was made, as suggested and described in last year's report. (See Part IV, p. 2803, Chief of Engineer's Report for 1893.)

The work on the southerly breakwater was completed September 26; that over the south pier on the 10th of November, when the contract was closed. Eight clumps of piles were built under the contract, viz, 3 at the east end of the south pier, 3 at the north, and 2 at the southwest end of the southerly breakwater.

As might have been expected, the timbers in the south pier, which was built in 1870, were very much decayed, and more of the work had to be removed than had been anticipated.

The total cost of the work done under the contract was as follows:

Superstructure over 2,500 linear feet of southerly breakwater	$19,443.19
Superstructure over 1,225 linear feet of south pier	7,711.27
Eight clumps of piles	716.80
Extra decking on south pier, steel plates, etc	1,249.26
	29,120.52

PRESENT CONDITION OF THE WORKS.

The easterly and southerly breakwaters and the outer portions of the north and south piers, having all lately been furnished with new superstructure, and the greater portion with new decking, are all in excellent condition. The inner portions of the last-named piers are in bad condition, but these being used, together with the adjoining land, by private parties, it has been the policy of the U. S. Government not to expend any money on their repairs, and no such expenditure is recommended. The exterior breakwater, however, requires attention. Not only is a portion of this work old and decayed, having been built in 1881 and 1882, and unfit for a work of such importance and such exceptional exposure to severe gales, but in the most violent of gales that have occurred for many decades, on the 18th of May last, this breakwater sustained severe damages in various places throughout its whole length, which are of such nature that if not repaired before very long the damages will surely be considerably increased in extent in case of repeated stormy weather. In brief, the principal damages consist in the general tearing off and removal of most of the heavy 10 by 12 inch decking, the forcing out of large portions of the southerly wall by the overflowing high waves, in many places as much as 4 to 6 courses in depth, and in washing out of great quantities of the stone filling.

Based on a personal inspection an estimate has been made of the cost of repairing this breakwater, covering the same with a decking across its full width and refilling with stone wherever required. The estimate is made in four different parts, as follows:

1. Entire renewal of the superstructure over the oldest (middle portion) of the breakwater, 2,200 linear feet in length.
2. Repair of damages, where needed, to the part west of middle section, a distance of 800 feet.
3. Repairs, in part, to the portion eastward, which is badly damaged in several places, even on the part built but five years ago, in 1889. This section is 2,400 feet in length.
4. Decking over the whole length and width of the breakwater.

1. Middle portion, 2,200 linear feet:	
897,600 feet, B. M., pine timber, at $28	$25,132.80
90,000 pounds drift bolts, at 3 cents	2,700.00
381 cords of stone, at $6.50	2,476.50
Total	30,309.30
2. Western portion, 800 linear feet:	
116,800 feet, B. M., pine timber, at $28	3,270.40
12,000 pounds drift bolts, at 3 cents	360.00
123 cords of stone, at $6.50	799.50
Total	4,429.90
3. Easterly portion, 2,400 linear feet:	
467,200 feet, B. M., pine timber, at $28	13,081.60
47,000 pounds drift bolts, at 3 cents	1,410.00
293 cords of stone, at $6.50	1,904.50
Total	16,396.10

4. Decking, 5,400 linear feet:	
818,000 feet, B. M., pine decking, at $18	$14,724.00
54,000 pounds spike, at 4 cents	2,160.00
Total	16,884.00

RECAPITULATION.

1. Middle portion	$30,309.30
2. Westerly portion	4,429.90
3. Easterly portion	16,396.10
4. Decking	16,884.00
	68,019.30
Add 10 per cent for contingencies, etc	6,801.93
Grand total	74,821.23

An atlas has been prepared, showing first the location of all the United States works of improvement in this district on a map of the State of Illinois, and further detail maps of each of the separate works, together with statements in tabular form for Chicago and Calumet harbors and Calumet River concerning the improvements of these works, cross sections of the various structures employed, data as to when, where, and how made, and under whose direction as far as has been possible to ascertain from the reports of the Chief of Engineers, inspectors' journals, and other available sources. In connection with this I have prepared a table, respectfully submitted herewith, which gives a comparison of the cost per 100 linear feet of all the different structures used in this harbor, cross sections of which are shown thereon. To make the comparison practicable, the computation has been made for the uniform height of 20½ feet above the lake bottom, and the estimate of cost has been based on a uniform price—one considered fair and safe for estimates—for each kind of material.

Percentages of the cost of each of the materials, as compared with cost of the structure as a whole, are also given. It is expected that this table will be found useful in preparing approximate estimates of cost of proposed work.

The U. S. light-house at the mouth of the river on the north pier, which was erected in or about the year 1865, is being removed from here by the U. S. Light-House Board to Twin River Point, Michigan.

Being an old established landmark, and its exact location accordingly of value and interest, I have, in compliance with your orders, made a minute survey of the site on which it is located (originally a pier head built in the lake in 1859), with the keeper's dwelling, which is to remain thereon.

On the sketch made from this survey and submitted herewith are shown three reference points (constructed as described below), in their relative positions with reference to the center of the light-house tower, at which point a similar mark will be established.

Each of said reference marks was made as follows (see sketch herewith):

A hole was made in the ground deep enough to place a small board flat at its bottom and with the top surface thereof at mean low-water level of Lake Michigan (1.8 feet above Chicago city datum). Two sewer pipes, of 6 inches inside diameter, were then placed vertically one above the other on top of the board. The natural ground around the bottom was packed down and a ring of concrete (1 part Portland cement and 2 parts sand) was placed around the bottom of the pipe to fix its position. A plumb-bob, made from a quart bottle filled with wet sand and suspended by means of a copper wire through its cork from a tripod, was so placed as to pass through the sewer pipe to the bottom, the wire forming an absolute plumb line inside thereof. To make sure of this being so the bottom of the bottle was surrounded with grout to prevent oscillation. A dry mixture of cement (1 part) and fine sand (2 parts) was then carefully sifted down into the pipe until this was nearly full, when water was poured over it and allowed to pass through the composition.

When the concrete was saturated the pipe was filled to top and a ring, about 3 feet in diameter, of the same material formed around the top of the pipe. A small nipple of cement was formed around the wire, to indicate its place. The wire was then cut off close to the nipple.

The holes in the ground around the points were next filled up, the sand used therefor being saturated with water to pack well, and, after the cement had set, observations were made to obtain angles and distances determining the relative positions of these points to the center of the tower, etc., as indicated on the sketch.

The center of the tower has been indicated as "Point 1," and will be marked by a single copper wire (No. 16). Point 2 has a copper wire or cord made of two strands (of No. 20 wire). Nos. 3 and 4 have respectively three and four strands of wire of the same number.

There will be no opportunity to establish Point No. 1 until the beginning of next month, after the tower has been removed.

A portion of a wreck of one of the vessels foundered in the gale of May 18 last is lying at a point 930 feet south by 240 feet west from the southwest corner of the southerly breakwater and nearly in the line taken by smaller vessels entering the outer basin from the south.

The following maps and drawings are respectfully submitted with this report:

1. A general map of the harbor and vicinity.
2. A table showing distribution of materials in the rebuilding of superstructure over the southerly breakwater and the south pier.
3. A table showing cross sections of the different structures used in the piers and breakwaters of this harbor, and the comparative cost of the same.
4. Sketch showing the light-house site.
5. Sketch showing the manner of constructing the reference points for locating the center of the light-house tower.

Mr. Axel Fahlstrom acted in a very satisfactory manner as inspector at the building of the superstructure.

I am, captain, very respectfully, your obedient servant,

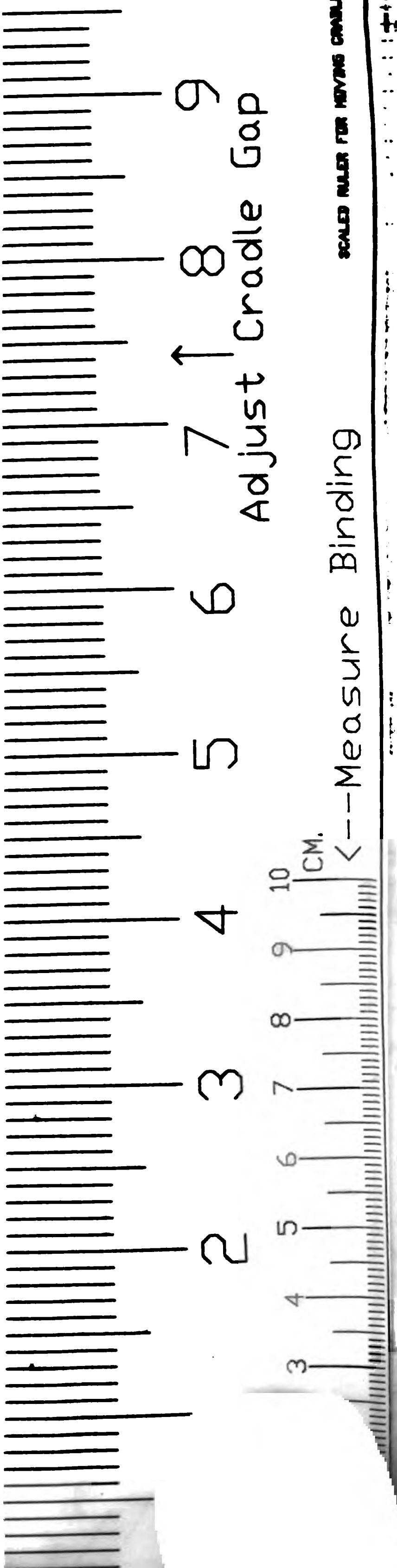
G. A. M. Liljencrantz,
Assistant Engineer.

Capt. W. L. Marshall,
Corps of Engineers, U. S. A.

Table showing in detail the distribution of materials in rebuilding superstructure, Chicago Harbor, 1893.

SOUTHERLY BREAKWATER.

Detail sections.		Side timbers.		Cross-ties.		Blocks.		Longitudinals.		
Number.	Length.	Linear feet.	Feet, B. M.	No.	Feet, B. M.	No.	Feet, B. M.	Linear feet.	No. of scarf.	Feet, B. M.
	Feet.									
1	100	1,300	15,600	39	11,700	3	840	600	39	6,520
2	100	1,300	15,600	39	11,700	....	....	600	39	6,520
3*	95	1,271	15,252	38	11,490	2	560	477	28	5,143.3
4	100	929	11,148	27	4,320	....	....	417	24	4,490
5	100	900	10,800	26	4,160	....	....	400	26	4,346.7
6	100	900	10,800	26	4,160	....	....	400	26	4,346.7
7	100	900	10,800	26	4,160	....	....	400	26	4,346.7
8	100	1,000	12,000	33	5,280	....	....	400	26	4,346.6
9	100	800	9,600	26	4,160	....	....	400	26	4,346.7
10	100	800	9,600	26	4,160	....	....	400	26	4,346.7
11	100	800	9,600	26	4,160	....	....	400	26	4,346.6
12	100	800	9,600	26	4,160	....	....	400	26	4,346.7
13	100	900	10,800	26	4,160	....	....	400	26	4,346.7
14	100	815	9,780	26	4,160	....	....	400	26	4,346.6
15	100	800	9,600	26	4,160	....	....	400	26	4,346.7
16	100	800	9,600	26	4,160	....	....	400	26	4,346.7
17	100	800	9,600	26	4,160	....	....	400	26	4,346.6
18	100	800	9,600	26	4,160	....	....	400	26	4,346.7
19	100	800	9,600	26	4,160	....	....	400	26	4,346.7
20	100	800	9,600	26	4,160	....	....	400	26	4,346.6
21	100	800	9,600	26	4,160	....	....	400	26	4,346.7
22	100	800	9,600	26	4,160	....	....	400	26	4,346.7
23	100	800	9,600	26	4,160	....	....	400	26	4,346.6
24	100	800	9,600	26	4,160	....	....	400	26	4,346.7
25	100	903	10,836	26	4,160	2	280	400	26	4,346.7
Total	2,495	22,318	267,816	696	127,690	7	1,680	10,494	676	113,953.4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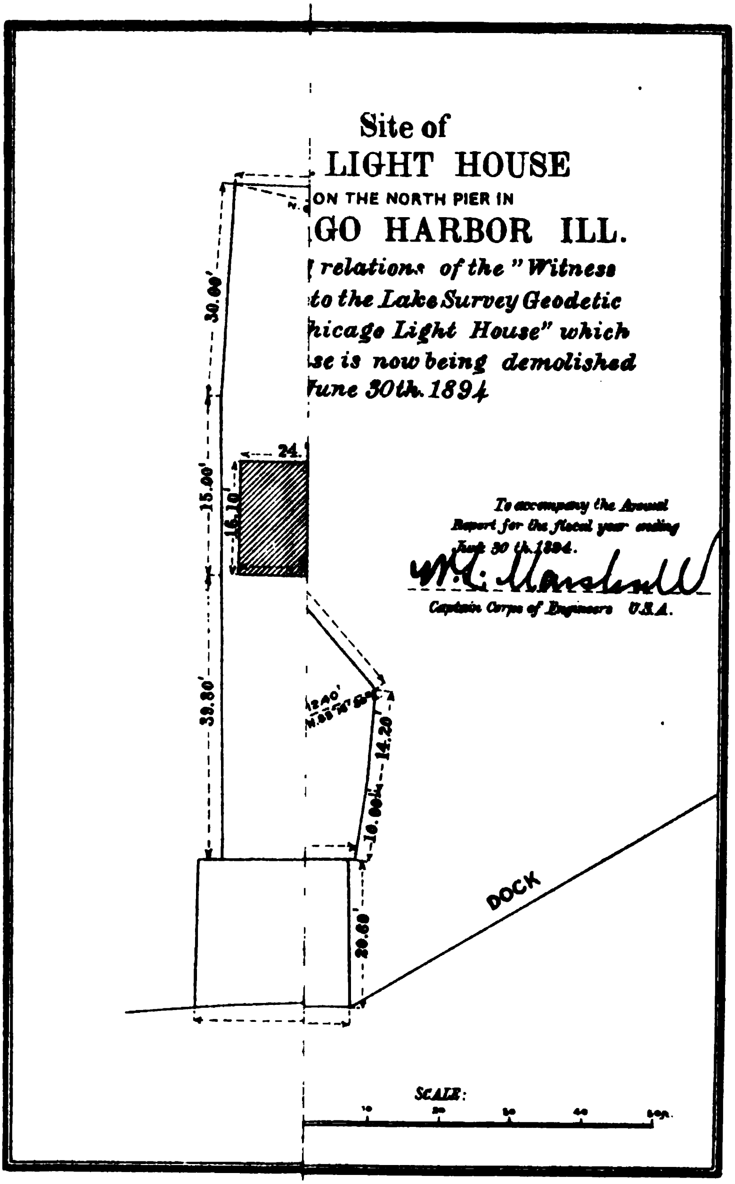


Site of

LIGHT HOUSE

ON THE NORTH PIER IN

GO HARBOR ILL.

relations of the "Witness

to the Lake Survey Geodetic

hicago Light House" which

se is now being demolished

June 30th. 1894

To accompany the Annual

Report for the fiscal year ending

June 30 th 1894.

W. L. Marshall

Captain Corps of Engineers U.S.A.

The Friedenwald Co. Photo-Lith., Balto., Md. Eng. 58 8.

***Table showing in detail the distribution of materials in rebuilding superstructure, Chicago Harbor, 1893*—Continued.**

SOUTHERLY BREAKWATER—Continued.

Detail sections.		Shimmings (feet, B. M.).	Total (feet, B. M.).	Cost.	Wrought-iron drift bolts.			Cost.
Number.	Length.				No. 32-inch.	No. 20-inch.	Pounds.	
	Feet.							
1	100	....	34,660	$901.16	368	122	3,995.2	$97.88
2	100	....	33,820	879.32	342	97	3,621.2	88.72
3*	95	1,542	33,987.3	883.66	335	95	3,547	86.90
4	100	168	20,126	523.28	233	96	2,634.6	64.55
5	100	130	19,436.7	505.35	234	91	2,615.6	64.08
6	100	130	19,436.7	505.35	234	91	2,615.6	64.08
7	100	478	19,784.7	514.38	234	91	2,615.6	64.08
8	100	1,224	22,850.6	594.13	260	91	2,849.6	69.82
9	100	1,140	19,246.7	500.42	207	114	2,501.4	61.28
10	100	1,102	19,208.7	499.43	207	110	2,479	60.73
11	100	378	18,484.6	480.61	207	90	2,367	57.99
12	100	912	19,018.7	494.49	214	95	2,458	60.22
13	100	156	19,462.7	506.03	231	90	2,583	63.29
14	100	1,737	20,023.6	520.60	242	98	2,726.8	66.82
15	100	3,624.6	21,731.3	565.01	207	102	2,434.2	59.64
16	100	738	18,844.7	489.96	207	96	2,400.6	58.81
17	100	78	18,184.6	472.80	208	91	2,381.6	58.35
18	100	2,100	20,206.7	525.38	208	97	2,415.2	59.18
19	100	36	18,142.7	471.72	208	90	2,376	58.21
20	100	249	18,355.6	477.25	208	90	2,376	58.21
21	100	....	18,106.7	470.77	208	90	2,376	58.21
22	100	....	18,106.7	470.78	208	90	2,376	58.21
23	100	....	18,106.6	470.77	208	90	2,376	58.21
24	100	....	18,106.7	470.77	208	90	2,376	58.21
25	100	100	19,722.7	512.79	229	93	2,581.8	63.26
Total	2,495	16,021.6	527,162	13,706.21	5,855	2,390	66,079	1,618.94
Average for 100 feet (30 feet wide)			34,734	903.10	....	....	3,784	92.71
Average for 100 feet (16 feet wide)			19,305	501.91	....	....	2,496	61.16

Detail sections.		Decking (feet, B. M.).	Cost.	Spikes (lbs.).	Cost.	Stone (cords).	Cost.	Total cost.	Width of pier.	Number of courses.	Date completed.
Number.	Length.										
	Feet.								*Feet.*		
1	100	13,720	$246.96	966	$36.22	....	....	$1,282.22	30	6.5	June 30
2	100	14,000	252.00	986	36.97	23.29	$104.81	1,361.82	30	6.5	June 27
3*	95	12,710	228.78	895	33.56	....	....	1,232.90	30	6	June 17
4	100	7,000	126.00	493	18.49	....	....	732.32	16	4.5	June 20
5	100	7,000	126.00	493	18.49	....	....	713.92	16	4.5	June 23
6	100	7,000	126.00	493	18.49	....	....	713.92	16	4.5	June 24
7	100	7,000	126.00	493	18.49	....	....	722.95	16	4.5	July 6
8	100	7,000	126.00	493	18.49	....	....	808.44	16	5	July 11
9	100	7,000	126.00	493	18.49	....	....	706.19	16	4	July 12
10	100	7,000	126.00	493	18.49	....	....	704.65	16	4	July 14
11	100	7,000	126.00	493	18.49	....	....	683.09	16	4	July 17
12	100	7,000	126.00	493	18.49	....	....	699.20	16	4	July 21
13	100	7,000	126.00	493	18.49	....	....	713.81	16	4.5	July 24
14	100	7,000	126.00	493	18.48	....	....	731.90	16	4	July 27
15	100	7,000	126.00	493	18.49	....	....	769.14	16	4	July 27
16	100	7,000	126.00	493	18.49	....	....	693.26	16	4	July 29
17	100	7,000	126.00	493	18.49	....	....	675.64	16	4	July 31
18	100	7,000	126.00	493	18.48	....	....	729.04	16	4	Aug. 7
19	100	7,000	126.00	493	18.49	....	....	674.42	16	4	Aug. 7
20	100	7,000	126.00	493	18.49	....	....	679.95	16	4	Aug. 10
21	100	7,000	126.00	493	18.49	....	....	673.47	16	4	Aug. 12
22	100	7,000	126.00	493	18.48	....	....	673.47	16	4	Aug. 18
23	100	7,000	126.00	493	18.49	....	....	673.47	16	4	Aug. 31
24	100	7,000	126.00	493	18.49	....	....	673.47	16	4	Sept. 7
25	100	7,000	126.00	493	18.48	....	....	720.53	16	4.5	Sept. 7
Total	2,495	194,430	3,499.74	13,693	513.49	23.29	104.81	19,443.19	.....	.....	....
Average for 100 feet (30 feet wide)		13,705	246.69	965	36.19	....	....	†1,278.69	.....	.....	....
Average for 100 feet (16 feet wide)		7,000	126.00	493	18.49	....	....	†707.56	.....	.....	....

*Angle crib. †Not including stone.

Table showing in detail the distribution of materials in rebuilding superstructure, Chicago Harbor, 1893—Continued.

SOUTH PIER.

Detail sections.		Side timbers.		Cross-ties.		Blocks.		Longitudinals.		
Number.	Length.	Linear feet.	Feet, B. M.	No.	Feet, B. M.	No.	Feet, B. M.	Linear feet.	No. of scarf.	Feet, B. M.
	Feet.									
1	100	855	10,260	26	5,200	2	360	400	24	4,320
2	100	800	9,600	24	4,800			400	24	4,320
3	100	800	9,600	26	5,200			400	20	4,266.6
4	100	824	9,888	26	5,200			400	24	4,320
5	100	800	9,600	24	4,800			400	18	4,240
6	100	800	9,600	26	5,200			400	18	4,240
7	100	820	9,840	26	5,200			400	19	4,253.3
8	100	824	9,888	24	4,800			400	18	4,240
9	100	887	10,644	26	5,200			400	26	4,346.7
10	100	821	9,852	26	5,200			400	26	4,346.6
11	100	800	9,600	26	5,200			400	26	4,346.7
12	100	800	9,600	24	4,800			400	24	4,320
13	25	200	2,400	8	1,600	1	180	100	8	1,106.7
Total	1,225	10,031	120,372	312	62,400	3	540	4,900	275	52,666.6

Detail sections.		Shimmings (feet, B. M.).	Total (feet, B. M.).	Cost.	Wrought-iron drift bolts.			Cost.
Number.	Length.				No. 32-inch.	No. 20-inch.	Pounds.	
	Feet.							
1	100	510	20,650	$536.90	230	98	2,618.8	$64.16
2	100	950	19,670	511.42	203	100	2,387	58.48
3	100	1,489	20,555.6	534.45	200	98	2,348.8	57.55
4	100	148	19,556	508.45	212	89	2,406.4	58.96
5	100	290	18,930	492.18	192	81	2,181.6	53.45
6	100	1,076	20,116	523.02	209	86	2,362.6	57.88
7	100	1,388	20,681.3	537.71	213	101	2,482.6	60.81
8	100	926	19,854	516.21	217	83	2,417.8	59.24
9	100	1,662	21,852.7	568.17	256	82	2,763.2	67.70
10	100	391.4	19,790	514.54	207	101	2,428.6	59.50
11	100	1,000	20,146.7	523.81	208	100	2,432	59.59
12	100	950	19,670	511.42	200	86	2,281.6	55.90
13	25	780	6,066.7	157.73	70	25	770	18.86
Total	1,225	11,560.4	247,539	6,436.01	2,617	1,130	29,881	732.08
Average for 100 feet (20 feet wide)			20,207	525.39			2,439	59.76

Detail sections.		Decking (feet, B. M.).	Cost.	Spikes (lbs.).	Cost.	Total cost.	Width of pier.	Number of courses.	Date completed.
Number.	Length.								
	Feet.						*Feet.*		
1	100					$601.06	20	4	Nov. 9
2	100					569.90	20	4	Nov. 9
3	100					592.00	20	4	Oct. 31
4	100					567.41	20	4	Oct. 20
5	100					545.63	20	4	Oct. 14
6	100					580.90	20	4	Oct. 11
7	100					598.52	20	4	Oct. 5
8	100					575.45	20	4	Sept. 29
9	100					635.87	20	4	Sept. 26
10	100	6,100	$109.80	426	$15.97	699.81	20	4	Sept. 22
11	100	9,000	162.00	627	23.51	768.91	20	4	Sept. 13
12	100	9,000	162.00	627	23.51	752.83	20	4	Sept. 9
13	25	2,250	40.50	157	5.89	222.98	20	4	Aug. 31
Total	1,225	26,350	474.30	1,837	68.83	7,711.27			
Average for 100 feet (20 feet wide)		9,000	162.00	627	23.51	‡ 585.15			

‡ Not including decking.

Readings of the gauge at Chicago, Ill., 1893.

[Plane of reference: Chicago city datum. Low water of 1847.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	0.20	0.40	—0.30	0.10	0.43	1.60	1.37	1.30	1.07	0.80	0.33	0.07
2	0.07	0.30	—0.13	0.07	0.67	1.20	1.30	1.43	1.03	0.73	0.53	0.39
3	0.23	0.17	0.13	0.48	0.73	1.07	1.23	1.23	1.27	0.70	0.44	0.70
4	0.00	—0.17	0.43	—0.03	0.73	1.30	1.17	1.14	0.90	0.77	0.43	—0.07
5	0.50	0.20	—0.20	0.23	0.73	1.27	1.33	1.63	1.23	0.77	0.37	—0.07
6	0.07	0.50	—0.33	0.53	0.53	1.10	1.64	1.63	1.30	0.48	0.40	—0.03
7	0.17	—0.30	—0.23	—0.33	0.53	1.07	1.43	1.40	1.17	0.67	0.57	—0.03
8	—0.10	—0.30	0.13	—0.07	0.90	0.93	1.53	1.20	1.20	0.67	0.40	0.00
9	0.43	0.27	0.20	0.30	0.93	0.97	1.00	1.33	1.20	0.70	0.63	0.13
10	0.07	0.06	0.13	0.30	0.83	1.27	1.23	1.20	1.13	0.80	0.50	0.03
11	0.10	—0.13	—0.10	0.47	0.60	1.30	1.33	1.37	1.30	0.80	0.50	0.17
12	0.27	—0.13	0.13	0.33	0.83	1.20	1.30	1.50	1.27	1.00	0.30	0.17
13	—0.17	0.10	0.30	0.28	0.97	1.20	1.23	1.40	1.20	0.90	0.47	0.03
14	0.13	—0.13	1.00	0.60	0.77	1.83	1.47	1.30	1.03	0.97	0.38	0.00
15	0.10	0.07	0.30	0.50	1.00	1.47	1.04	1.37	0.97	0.53	0.13	0.07
16	0.67	0.20	0.33	0.10	0.93	1.23	1.57	1.20	0.80	0.47	0.13	0.68
17	—0.13	0.50	0.27	0.47	0.90	1.17	1.53	1.20	0.63	0.57	0.33	0.37
18	—0.13	0.00	0.20	0.47	0.83	1.13	1.57	1.20	0.73	0.83	0.27	—0.23
19	—0.23	0.97	0.17	0.80	0.83	1.23	1.57	1.53	0.93	0.73	0.37	0.47
20	—0.50	—0.10	0.13	0.97	0.80	1.37	1.53	1.33	1.67	0.83	—0.17	—0.33
21	—0.23	—0.13	0.13	0.70	0.73	1.40	1.37	1.27	0.80	0.87	0.33	—0.33
22	—0.33	—0.03	0.53	0.70	0.83	1.03	1.17	1.18	1.03	0.67	0.33	0.20
23	—0.20	—0.20	0,27	0.40	0.70	1.13	1.30	1.13	1.10	0.67	0.37	—0.07
24	—0.33	—0.07	—0.30	0.70	0.87	1.10	1.33	1.17	1.03	0.77	0.37	0.50
25	0.00	—0.13	0.27	1.27	1.20	1.20	1.23	1.23	0.80	0.73	0.03	0.83
26	—0.13	—0.03	0.33	0.77	1.33	1.17	1.34	1.13	0.57	1.08	0.07	0.33
27	0.17	0.00	0.43	0.47	1.40	1.20	1.33	1.17	0.73	0.78	0.40	0.07
28	0.17	0.67	0.40	0.73	1.10	1.30	1.23	1.53	0.77	0.80	0.37	—0.10
29	0.13	......	0.30	1.03	0.97	1.47	1.24	1.50	0.60	0.90	0.40	0.37
30	0.17	......	0.07	1.13	1.23	1.50	1.33	1.27	0.80	0.60	0.23	0.50
31	0.23	......	0.30	......	1.53	......	1.47	1.10	......	0.10	......	0.20
Mean	0.05	0.09	0.17	0.48	0.88	1.23	1.35	1.31	1.01	0.73	0.34	0.16

COMMERCIAL STATISTICS.

Amount of revenue collected during fiscal year, $5,899,786.80.

Arrivals and clearances of vessels.

	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	5,052	3,809,134	5,064	3,927,605
Sail	2,636	802,319	2,630	830,896
Total	7,688	4,611,453	7,694	4,758,501

Receipts and shipments by lake during calendar year 1893, Chicago Harbor.

Receipts.	Tons.	Shipments.	Tons.
Coal	1,346,274	Flour	156,519
Iron	8,608	Grain	2,267,731
Stone and marble	16,381	Lard	19,082
Fish	6,184	Meats	2,403
Lumber, wood, etc	2,673,847	Lead	101,767
Flour, salt, sugar, and sirup	190,624	Oil and oil cake	22,398
Cement and plaster	61,557	Hay	1,951
Potatoes	12,015	Iron	3,655
Coffee and tea	4,290	Sugar and sirup	15,951
Grain	5,121	Seed	131,002
Miscellaneous merchandise	613,325	Coal	4,749
Hardware, nails, etc	35,264	Miscellaneous merchandise	258,265
Total	4,973,490	Total	2,985,473

K K 2.

IMPROVEMENT OF CALUMET HARBOR, ILLINOIS.

The object of this work is to provide a deep entrance to Calumet River and the port of South Chicago, Ill.

This is effected in the usual manner by dredging a channel and protecting the dredged area by parallel piers, 300 feet apart, projecting into the lake from the river's mouth.

Condition of the work June 30, 1894.—Work was begun on this harbor in 1870, and at the beginning of the fiscal year 2,020 linear feet of the south pier and 3,640 linear feet of the north pier had been constructed, which completed the existing project as far as pier work is concerned, but the south pier should be prolonged 800 feet to protect the channel from drifting sands.

On account of the present urgent necessity for maintaining the work already done by proper renewals of decayed parts, no project for further extending the work has been submitted, but the estimates herein submitted are for maintenance only.

At the beginning of the fiscal year a contract was in force with the Wisconsin Dredge and Dock Company, of Manitowoc, Wis., for rebuilding superstructure over 900 linear feet of the north pier and over 700 linear feet of the south pier, and for the construction of about 320 linear feet of pile revetment at the westerly end of the south pier. All the superstructure under this contract had been completed and there remained to be done only the pile revetment. This was completed during the year, but its length was reduced to 286 feet, as the remainder of it had been done by a private corporation in connection with their slip.

The channel is still in good condition and equal at present to the demands upon it in depth and width; but the piers in great part are in a bad condition: more than 1,800 linear feet of pier work is rotten and falling to pieces, and about half as much more in need of early renewal. There are also two places where the piers have been damaged by collision needing repair.

Although the universal depression of the past year has resulted in a diminution in tonnage resorting to this harbor during the past year, there is an unmistakable increase in the importance and magnitude of interests dependent on marine transportation seeking locations at South Chicago. Several large grain elevators have been constructed, and others are now in process of construction. When all of the elevators now projected are completed it is estimated that their capacity will be 13,000,000 bushels. The lumber and coal distributive business is also increasing. This harbor is one of the most commodious on Lake Michigan and can be deepened readily to meet the requirements of the 20-foot channel between Duluth, Chicago, and Buffalo. It is at the mouth of the Calumet River, which may be cheaply improved to almost any extent demanded without interference with existing constructions, and it is confidently expected that the demand for increased depths of channels at the city of Chicago will be met at the Calumet. This harbor and port is now within the city limits of Chicago, and the local jealousies that have retarded its development may reasonably be expected to rapidly subside.

PROPOSED APPLICATION OF FUNDS REQUIRED FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

It is proposed to apply the funds now on hand and those required for the fiscal year ending June 30, 1896, to rebuilding superstructures over the piers and to maintaining in good condition the works protecting the entrance to Calumet River. It is important that the south pier be extended at least 800 linear feet to protect the channel against drifting sands, and that an outer breakwater be constructed to shelter the space in front of the ends of the piers to allow vessels to enter the river during storms, but these works are less urgent than the needs of the existing construction.

As soon as the existing works can be put in good order, estimates will be submitted.

Money statement.

July 1, 1893, balance unexpended	$10,380.94
June 30, 1894, amount expended during fiscal year	4,243.24
July 1, 1894, balance unexpended	6,137.70
July 1, 1894, outstanding liabilities	104.44
July 1, 1894, balance available	6,033.26
Amount (estimated) required for maintenance	30,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	30,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Expenditures for fiscal year 1894.

Rebuilding superstructure north and south piers and repair of revetment at westerly end of south pier:

Contractor's estimates	$3,339.07
Services of assistant engineer	600.00
Services (office)	150.00
Services of watchman	60.00
Office supplies, telephone service, ice, gas, etc	61.64
Street-car tickets	10.00
Fuel for office	11.00
Traveling expenses	11.90
Shingles	.63
Total	4,243.24

Abstract of contracts for improving Calumet Harbor, Illinois, in force during the fiscal year ending June 30, 1893.

Name and address of contractor.	Nature of contract.	Date.	To expire—
Wisconsin Dredge and Dock Co., Manitowoc, Wis.	Rebuilding superstructure, 1,600 linear feet and 320 linear feet of sheet piling.	Oct. 28, 1892	Dec. 1, 1893

Completed October 17, 1893.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1894.

CAPTAIN: I have the honor to submit herewith a report on operations in Calumet Harbor, Illinois, during the fiscal year ending June 30, 1894.

On the 1st of July, 1893, there was one contract in force for work of improving Calumet Harbor, Illinois, by rebuilding the superstructure, 4 courses in height, over 900 linear feet of the north pier and over 700 linear feet of the south pier, in all 1600 linear feet, and by the construction of about 320 linear feet of sheet piling in front of the old plank beam revetment at the inner or westerly end of the south pier.

The contract was entered into with the Wisconsin Dredge and Dock Company, of Manitowoc, Wis., the lowest responsible bidders, on the 28th of October, 1892.

Work under the contract commenced on the 21st of November, 1892, and all the superstructure was completed before the close of that fiscal year, or on the 20th of May, 1893, and was fully accounted for in last year's report.

The construction of the sheet piling at the south pier was commenced on the 19th of May, 1893, but its progress was long delayed by the inability of the contractors to secure the necessary plank for sheet piling. It was, however, completed one and one-half months before the time fixed for the expiration of the contract, or on the 14th of October, 1893.

The projected length of the new sheet piling was 320 feet, but only 286 were found to be required, the Calumet and Chicago Canal and Dock Company having built the balance in connection with the corner for their dock, forming the easterly part of their slip.

The total amount expended for material and work under this contract was as follows:

308,819 feet, B. M., pine timber, at $27	$8,338.11
30,585 feet, B. M., oak timber, at $45	1,376.32
36,747.8 pounds iron driftbolts, at 3 cents	1,102.44
525 pounds iron spikes, at 3.9 cents	20.47
6,025 pounds iron tie-rods, at 5 cents	301.25
51 white-oak piles, at $9	459.00
545 cubic yards of dredging, at 20 cents	109.00
Total	11,706.59

This amount was distributed in the different parts of the work as follows:

900 linear feet of superstructure, north pier	$5,191.74
700 linear feet of superstructure, south pier	4,105.51
286 linear feet of sheet piling	2,300.34
545 cubic yards of dredging, at 20 cents	109.00
Total	11,706.59

This gives the average cost per linear foot of the different works:

Superstructure:		
North pier	per linear foot.	$5.77
South pier	do	5.86
Sheet piling	do	8.04

The prices for the superstructure do not include stone, as there was no stone required beyond what was already in the piers.

The contract was closed and the last estimate for payment was submitted on the 16th of October, 1893.

PRESENT CONDITION OF THE WORKS.

The damages done to the north pier, as reported last year, have not been repaired. This should be done.

The sheet piling built in front of the old plank-beam revetment at the inner end of the north pier is now in bad condition and needs repair or rather renewal before long.

When this is done I believe it would be to the best advantage if the whole of both the now decaying sheet piling and the old plank-beam revetment were entirely removed, together with the stone filling, and new sheet piling built on the original dock line, to wit, the river face of the plank beam, as it is next to impossible to secure a row of piling in good alignment, and well driven, as long as the old work with a great quantity of stone at the bottom remains in place. This was demonstrated at last year's work on the south pier. About 1,500 linear feet (1,300 feet on the north and 200 on the south pier) of superstructure is in need of renewal. There will, however, not be needed more than 50 cords of new stone in all for both the piers.

The comparative condition of the piers is about as follows:

Condition of the works, etc.	North pier.	South pier.	Total.
	Lin. feet.	*Lin. feet.*	*Lin. feet.*
In good condition	900	1,286	2,186
In fair condition	648	....	648
In bad condition	600	300	900
In worthless condition	1,367	204	1,571
Removed for building slips	125	230	355
Total	3,640	2,020	5,660

The channel is at present in good condition, but will rapidly fill up unless the south pier is extended further out into the lake. This should be done for a distance of not less than 800 feet, as there is very shallow water along the line of extension of this pier, and southerly and southeasterly winds wash the sand from this shallow part into the river channel.

Filling up of this channel is undoubtedly also done by the dumping of materials (dredged by private parties) directly opposite the mouth of the harbor at times when there is no inspector or other representative employed at this place.

ESTIMATE OF WORK NEEDED IN THIS HARBOR.

The estimate submitted in last year's report, none of the work therein proposed having been done, may be here repeated, viz:

Extension of south pier 800 linear feet, at $60	$48,000
1,837 linear feet new superstructure, at $12	22,044
Repairs of damages to piers	156
Total	70,200
Add 10 per cent for contingencies, etc	7,020
Grand total	77,220

GENERAL REMARKS.

About 600 linear feet of the elevated walk on the north pier is now of no use whatever, as for this distance there is land adjoining the pier on the north side. It is also partly burnt, from sparks scattered by passing tugs and locomotives, and partly rotten from age. This is mentioned because of said structure being in the way when the proposed renewal of the superstructure is to be made.

The office building (and boathouse) has just been repaired, which was very much needed, the structure being about to tumble down, owing to the fact that the bottom sills on which the building rested had become so decayed that the greater portion thereof had to be "shoveled" out when new sills were put in.

The following maps, etc., are respectfully submitted with this report:

1 General map of the harbor and vicinity.

2. Table showing distribution in detail of materials in rebuilding superstructure over north and south piers in 1893.

Mr. Axel Fahlstrom has faithfully performed the duties of inspector at the construction of pier work of the year.

I am, captain, very respectfully, your obedient servant,

G. A. M. Liljencrantz,
Assistant Engineer.

Capt. W. L. Marshall,
Corps of Engineers, U. S. A.

Table showing in detail the distribution of materials in rebuilding superstructure, Calumet Harbor, 1893, four courses high.

SOUTH PIER.

Detail sections.		Side timbers.		Cross-ties.		Blocks.		Longitudinals.			Shimmings.	Totals.
No.	Length.	Linear feet.	Feet, B. M.	No.	Feet, B. M.	No.	Feet, B. M.	Linear ft.	No. of scarfs.	Feet, B. M.	Feet, B. M.	Feet, B. M.
	Feet.											
1	100	668	8,016	25	5,000	3	540	200	9	2,120	2,446	18,122
2	100	728.5	8,742	24	4,800	....	....	400	12	4,160	1,119	18,821
3	100	800	9,600	26	5,200	....	....	400	13	4,173.3	1,048	20,021.3
4	100	800	9,600	26	5,200	....	....	400	13	4,173.3	80	19,053.3
5	100	813	9,756	32	6,400	....	....	232	12	2,480	652	19,288
6	100	800	9,600	26	5,200	....	....	400	13	4,173.4	112	19,085.4
7	100	821	9,852	25	5,000	....	....	400	12	4,160	....	19,012
Total	700	5,430.5	65,166	184	36,800	3	540	2,432	84	25,440	5.457	133,403
Average for south pier											779.6	19,058

Detail sections.		Wrought-iron drift bolts			Cost.
No.	Length.	No. 32.	No. 20.	Pounds.	
	Feet.				
1	100	246	74	2,628.4	$568.14
2	100	216	77	2,375.2	579.43
3	100	206	91	2,363.6	611.49
4	100	209	78	2,317.8	583.97
5	100	226	99	2,588.4	598.43
6	100	206	72	2,257.2	583.02
7	100	206	72	2,257.2	581.03
Total	700	1,515	563	16,787.8	4,105.51
Average for south pier		216.4	80.4	2,398.2	586.50

NORTH PIER.

Detail sections.		Side timbers.		Cross-ties.		Longitudinals.			Shimmings.	Totals.
No.	Length.	Linear feet.	Feet, B. M.	No.	Feet, B. M.	Linear ft.	No. of scarfs.	Feet, B. M.	Feet, B. M.	Feet, B. M.
	Feet.									
1	100	700	8,400	26	5,200	400	12	4,160	1,244	19,004
2	100	772.5	9,270	24	4,800	400	12	4,160	1,000	19,230
3	100	700	8,400	26	5,200	400	13	4,173.3	1,016	18,789.3
4	100	783	9,396	26	5,200	342	13	3,593.3	310	18,499.3
5	100	800	9,600	24	4,800	400	12	4,160	120	18,680
6	100	800	9,600	26	5,200	400	13	4,173.4	160	19,133.4
7	100	800	9,600	25	5,000	400	12	4,160	50	18,810
8	100	800	9,600	26	5,200	400	13	4,173.3	40	19,013.3
9	100	842	10,104	24	4,800	400	12	4,160	40	19,104
Total	900	6,997.5	83,970	227	45,400	3,542	112	36,913.3	3,980	170,263.3
Average for north pier									442.2	18,918.1
Average for both piers									589.8	18,979

Detail sections.		Wrought-iron drift bolts.			Cost.
No.	Length.	No. 32.	No. 20.	Pounds.	
	Feet.				
1	100	214	88	2,418.8	$585.67
2	100	190	90	2,214	585.63
3	100	170	112	2,157.2	572.03
4	100	193	88	2,229.8	566.37
5	100	206	72	2,257.2	572.07
6	100	206	72	2,257.2	584.32
7	100	*206	72	2,051.2	569.41
8	100	*206	72	2,051.2	574.90
9	100	*225	72	2,184.2	581.33
Total	900	1,816	738	19,820.8	5,191.73
Average for north pier	....	201.8	82	2,202.3	576.86
Average for both piers	....	208.2	81.3	2,288	581.06

* About half of these were 7-pound bolts.

COMMERCIAL STATISTICS.

Amount of revenue collected at nearest port of entry (Chicago) during fiscal year, $5,899,786.80.

Arrivals and clearances of vessels.

	Arrived.		Cleared.	
	No.	*Tons.*	*No.*	*Tons.*
Steam	400	522,384	389	494,203
Sail	148	46,230	153	56,941
Total	548	568,614	542	551,144

Receipts and shipments by lake during the calendar year 1893.

RECEIPTS.

	Tons.
Coal	117,602
Iron and iron ore	350,725
Cement and plaster	17,433
Salt	56,445
Lumber, etc	95,473
Miscellaneous	50,000
Total	687,678

SHIPMENTS.

Coal	100
Grain	213,382
Steel rails	2,237
Total	215,719

K K 3.

IMPROVEMENT OF CALUMET RIVER, ILLINOIS AND INDIANA.

The object of this work as far as yet authorized is to secure a channel 16 feet deep below United States harbor datum or ordinary low water in Lake Michigan, and 200 feet wide at bottom, from the mouth of the river to one-half mile east of Hammond, Ind., to increase the facilities for handling the rapidly growing commerce of this region and to afford relief to the overcrowded port of Chicago.

The history of the work is given in previous reports of the Chief of Engineers prior to 1890; and a résumé of the provisions of the river and harbor acts of July 5, 1884, August 5, 1886, and August 11, 1888, under which work was inaugurated on this river, will be found on p. 2142, Report of the Chief of Engineers for 1889.

Although the project contemplates the ultimate attainment of 16 feet depth of navigation over a width of 200 feet from the mouth of the Calumet River at Calumet Harbor to a point one-half mile east of Hammond, Ind., it will be seen from the acts cited that this stretch has heretofore been divided into two sections:

(1) From the mouth to the forks of Calumet River.

(2) From the forks of the Calumet (outlet to Calumet Lake) to one-half mile east of Hammond, Ind.

On the second section only desultory work has been done by direction of Congress, which work has been worse than useless, as the channels excavated have been filled up rapidly by slaughterhouse refuse and filth from manufacturing establishments and solid matter from the sewage poured into this dead stream.

On the first section systematic work has been carried on, and up to the close of the fiscal year ending June 30, 1894, 1,558,956 cubic yards of material had been removed from the channel, making a complete channel 3 miles and 3,340 feet, to the full width of 200 feet at bottom and 16 feet in depth, with the exception of about 9,000 cubic yards, more or less, of hardpan and rock still to be removed over a short section near One hundred and thirteenth street.

At the close of the fiscal year ending June 30, 1893, there were in force two contracts dated October 28, 1892, with the Sheboygan Dredge and Dock Company, of Sheboygan, Wis., for dredging 400,000 cubic yards below the Forks at 10.7 cents per cubic yard; the other with the Wisconsin Dredge and Dock Company, Manitowoc, Wis., for dredging 90,000 cubic yards above the Forks, at 13.7 cents per cubic yard.

Both contracts were completed during the year; 400,534 cubic yards were dredged under the former contract, of which 101,632 cubic yards were from the channel dredged in previous years, which had filled up to a great extent after the floods of June and July, 1892; under the second contract 91,962 cubic yards were dredged from the channel above the forks.

Upon the termination of the contract below the forks many complaints were received that the filling in of the lower river, noticed in the last annual report, was obstructing navigation by the larger vessels. There was on hand such a small amount of money available for this work of redredging that formal contract, after public advertisement, was not advisable. The contractor was requested to perform this work under the terms of his contract, but declined. The firm of W. A. McGillis & Co., however, were ready to undertake it at the same price as paid the contractors, i. e., 10.7 cents per cubic yard, and with th authority of the Chief of Engineers an informal or verbal agreement was made with them to redredge certain portions of the channel.

At the close of the fiscal year 20,946 cubic yards had been excavated from the channel near the mouth of the river, to secure a channel 100 feet wide and 16 feet deep below Chicago city datum, or 17 feet deep below United States harbor datum.

This dredging is still in progress.

In the last annual report the matter of the deterioration of the dredged channel is treated at considerable length, and it is now again to be noted. A resurvey of the improved portion of the river has been made, and the result shows that the channel has filled to the extent of one-fourth of the total dredging done; or, to restore the channel to its depth of 16 feet below Chicago city datum requires over 300,000 cubic yards of dredging. On the upper section, or between the Forks and one-half mile east of Hammond, the work is worse than useless under present conditions. Some parts of this channel have been dredged to a depth of 10 feet three times and as often filled in by slaughterhouse and other refuse.

The United States are merely scavengers for this region. There is practicably no navigation on this part of the river, and it may well await the progress of the general improvement of the channel from its mouth upstream.

It was estimated in the last annual report that $20,000 were then needed to restore the dredged channel below the Forks, and that $5,000 per mile would be required annually to maintain by dredging this channel. The survey named confirms these estimates. At the average cost of dredging already done, it will now require $35,000 to restore the channel throughout the 3⅔ miles that have been improved.

The report of Assistant Liljencrantz herewith gives necessary details regarding this improvement, and of the uses and results of this work.

PROPOSED APPLICATION OF FUNDS NOW ON HAND AND OF THOSE REQUIRED FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

The funds now on hand will be devoted to redredging in the channel near the mouth of the river below One hundred and eighth street. The funds asked for will be applied:

To redredging the improved section throughout, and in further extending the improvement from One hundred and eighteenth street southward.

No appropriations are advisable for the section between the Forks and one-half mile east of Hammond as long as the practice of filling the channels with filth of all kinds is in vogue.

Money statement.

July 1, 1893, balance unexpended	$72, 156. 01
June 30, 1894, amount expended during fiscal year	62, 323. 14
July 1, 1894, balance unexpended	9, 832. 87
July 1, 1894, outstanding liabilities	2, 241. 21
July 1, 1894, balance available	7, 591. 66
Amount (estimated) required for completion of existing project	745, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	200, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Statement of expenditures on Calumet River, Illinois and Indiana, fiscal year 1894.

BELOW THE FORKS.

Dredging in vicinity of One hundred and thirteenth street:		
Contractor's estimates	$42, 369. 64	
Services of assistant engineer	200. 00	
Services of inspector, etc	1, 869. 13	
Total		$44, 438. 77
Survey from mouth of river to One hundred and eighteenth street:		
Services of survey party	1, 984. 83	
Traveling expenses	45. 00	
Marsh shoes	20. 00	
Sounding poles, etc	22. 95	
Floats, lumber, cloth, tacks, etc	24. 11	
1 pair gloves	2. 00	
Field books	4. 80	
Repairing instruments	4. 25	
Total		2, 107. 94

Miscellaneous:			
Services clerks, draftsmen, etc		$1,210.00	
Office rent		150.00	
Office supplies		4.57	
Mileage and traveling expenses		18.14	
1 row boat		50.00	
1 anchor		3.00	
1 angle prism		4.50	
Branding figures		6.00	
Hose reel and timber scribe		5.00	
Brush-cutter, etc		4.48	
Paint, nails, etc		4.33	
Total below forks			$48,006.73

ABOVE THE FORKS.

Dredging between forks and one-half mile east of Hammond, Ind.:			
Contractor's estimates	12,319.70		
Services of assistant engineer	400.00		
Services of inspector	744.00		
Total		13,463.70	
Miscellaneous:			
Services clerks, draftsmen, etc		520.00	
Services survey party		94.75	
Boat hire		10.00	
Traveling expenses		56.63	
Lumber, etc., for stakes		11.16	
Office rent		150.00	
Office supplies		10.08	
Total above forks			14,316.41
Grand total			62,323.14

Abstract of contracts for improving Calumet River, Illinois and Indiana, in force during the fiscal year ending June 30, 1893.

Name and address of contractor.	Nature of contract.	Date.	To expire—
Wisconsin Dredge and Dock Company, Manitowoc, Wis. *	Dredging Calumet River above the forks, 90,000 cubic yards.	Oct. 28, 1892	Dec. 1, 1893
Sheboygan Dredge and Dock Company, Sheboygan Wis. †	Dredging Calumet River below the forks, 400,000 cubic yards.	....do.......	Do.

* Completed June 5, 1894.

† Completed May 10, 1894.

REPORT OF MR. G. A. M. LILJENCRANTZ, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Chicago, Ill., June 30, 1894.

CAPTAIN: I have the honor to submit herewith a report of operations in Calumet River, Illinois and Indiana, during the fiscal year ending June 30, 1894.

At the beginning of the year there were two contracts in force, both dated October 28, 1892, for improving Calumet River by dredging.

The first of these was for work to be done below the forks, in widening to 200 feet, deepening to 16 feet, and straightening the channel in conformity to the established dock lines, from One hundred and thirteenth street southward.

The second contemplated the deepening of the existing channel, where most needed, to a depth of 10 feet and a width of about 60 feet in the river above the forks.

WORK ON THE RIVER BELOW THE FORKS.

Contract for this work was entered into with the Sheboygan Dredge and Dock Company, of Sheboygan, Wis. Operations commenced on the 30th of May, 1893. The expiration of the contract was fixed at December 1, 1893. The price of the accepted bid was 10.7 cents per cubic yard of material removed.

At the close of the year ending June 30, 1893, the work had not been sufficiently far advanced to warrant any payment according to the terms of the contract, and the exact amount of work done up to that period was therefore not ascertained.

The sand-sucker spoken of in last year's report proved a disappointment in regard to its efficiency. Much was expected of this machine, but the expectations were not realized, because, it was claimed, the material to be removed was not of a suitable kind for this dredge, and after a short season of experimenting it was disposed of. The work proceeded with the elevator dredge, assisted by two, and part of the time three, dipper dredges.

On the 13th of October the cut, 2,300 feet in length, across the large bend in the river, was completed, whereby the length of the river channel was shortened one-quarter of a mile.

Much inconvenience and annoyance were experienced by the contractors from the constant filling up of a completed section of the work during the progress of the work in the adjoining section above. The frequently quite strong current through the partly made narrow channel above, with sides and bottom composed of soft material, would scour out and float down this material in large quantities, and deposit the same on reaching the channel with a greatly enlarged sectional area.

No section of the work was therefore finally accepted until the whole length of the cut was completed and the first sections, for which partial payments had been made, were cleaned up throughout. This cut, passing through a slough with but 1 foot or less of water, contained 221,720 cubic yards of material.

The elevator dredge was disposed of on the 6th of October and the "cleaning up" of the channel was done with the dipper dredges.

It was found about this time that the channel between One hundred and tenth and One hundred and thirteenth streets, which had been dredged under a previous contract, had been filled up with materials carried down with the current to such an extent as to make further extension of the channel useless. It was then decided to apply work under the contract to the redreding of this part of the river.

The elevator dredge was reengaged, and assigned the work of extending the new channel farther southward, while the three dipper dredges were given the work of redredging the old channel.

The elevator dredge kept at work until prevented by the very severe cold weather in December. After waiting in vain for a change in the temperature the contractors finally notified this office by telegram, on the 26th of said month, that they had concluded to lay up for the winter.

No part of this last section was completed or paid for in the fall.

Meantime the three dipper dredges proceeded to redredge the old channel, beginning at One hundred and thirteenth street, working northward, and completing at the close of the month of November a channel 1,150 feet in length, when, on account of the severe winter weather, work was closed for the season. Soundings were taken with difficulty in a strong current full of floating ice.

Extension of time for completing the contract was, at the request of the contractors, granted to July 1, 1894, in a letter from the Chief of Engineers, U. S. Army, dated November 14, 1894, subject to provisions made in the specifications governing the contract.

The work of extending the new channel was resumed by the elevator dredge on the 20th of March, 1894, and the channel completed to the contemplated limits, at One hundred and eighteenth street, on the 30th of April following.

One of the dipper dredges resumed the work on the old channel on the 30th of March. It was followed by a second dredge on the 10th of April, and on the 9th of May this work was finished, the contract completed and closed, and the final payment made.

Under the terms of this contract there were removed from the river channel as follows:

	Cubic yards.
In extending channel southward	298,902
In redredging old channel	101,632
Total	400,534

or 534 cubic yards in excess of the amount contracted for.

The last work under this contract was notable for the rapid progress made, the very slight loss of time for repairs or other causes, and for a depth of almost uniformly 2 feet below that required by the contract and paid for.

At about the time for closing this contract complaints had been received in this office to the effect that large vessels had great difficulty in navigating the lower portion of the river. Sufficient funds for furnishing necessary relief being available, the contractors were invited to do the additional work under the terms and at the price governing their contract; but on their refusal to accept the offer a special agreement was, with the sanction of the Chief of Engineers, entered into with Messrs. W. A. McGillis & Co., for doing the desired work at the same rate per cubic yard as paid under the contract, but according to scow measurement, as a considerable portion of the work would consist of cuts hardly more than a foot in depth.

Work under this agreement was commenced on the 24th of May, and now, at the close of the year, a channel 17 feet deep is completed between the harbor and the three railroad bridges, past the new and extensive South Chicago elevators and other establishments requiring communication with the lake through means of large-draft vessels. Up to the 30th of June, 20,945.85 cubic yards have been removed under the agreement, which was made for the removal of from 50,000 to 54,000 cubic yards.

WORK ON THE RIVER ABOVE THE FORKS.

The contract for improving the channel above the forks, by dredging at the rate of 13.7 cents per cubic yard, was given to the Wisconsin Dredge and Dock Company, of Manitowoc, Wis. The work under the contract commenced on the 15th of May, 1893, as stated in last year's report, but at the end of that year no section of required length was completed, and no payment was made to the contractors.

The first work done was from the forks southward where a channel 10 feet in depth and about 60 feet in width was made for a distance of 3,100 feet. This section was completed on the 15th of August, 1893, after the removal of 19,190 cubic yards of material, all of which was thrown over into the adjacent marsh. From the terminus of this section the channel had an original depth of over 10 feet as far as to the junction of Little and Grand Calumet rivers, and work was accordingly resumed at said junction and extended up to the Grand Calumet River, along the town of Burnham.

At the close of the season's work, on December 10, 1893, a channel, of similar width and depth with the one just described had been completed for a distance of 3,650 feet, or up to the Pennsylvania Railway Company's bridge.

Work was resumed at this place on the 7th of April, 1894, and a channel of dimensions as before was made for a distance of about 1,700 feet, when it was found, on the 5th of June, that the full amount of materials contracted for had been removed.

The work was stopped at once, soundings taken, estimate made, the contractors paid in full, and the contract closed.

The contract should have expired on December 1, 1893, but at the request of the contractors an extension of time for completing the contract was granted in a letter from the Chief of Engineers, dated November 11, 1893, subject to provisions set forth in the specifications governing the contract.

There were removed under the terms of the contract 91,962 cubic yards of material, or an excess of 1,962 cubic yards above the amount contracted for.

All materials removed under this contract were deposited on the adjacent river banks, two different methods being employed at different times to accomplish this end.

The first was the use of an extra dredge, by means of which a large box, into which the material was first dumped by the working dredge, was lifted over the river bank and there emptied.

The second method was by the aid of a sluicer, used by two previous contractors for similar work in this locality, leading from a hopper, into which the material is dumped, and by means of a stream of water washed through the sluice way over onto the river bank.

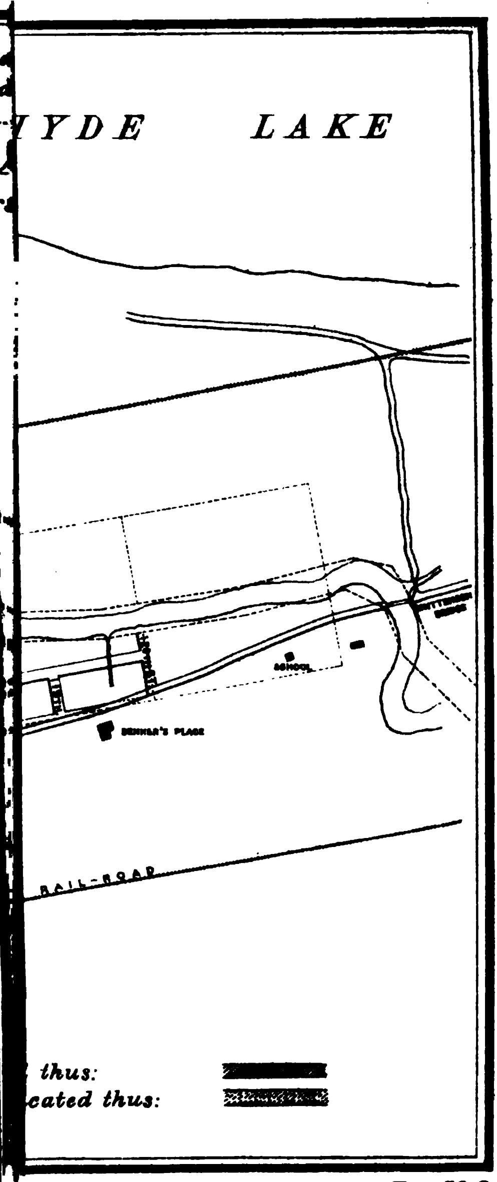
The previous contractors had, in my opinion, a much more effective way of applying the water jet, or rather, jets, for they used two or three, namely horizontally, directly behind the place of dumping and in the direction of the sluice, whereby the whole force of the streams was utilized in churning up and transporting the material.

The last contractor had the stream of water applied vertically, claiming that it would thus churn up the material with best effect. Thus, however, the water will pass through the sluice merely by the power of gravity.

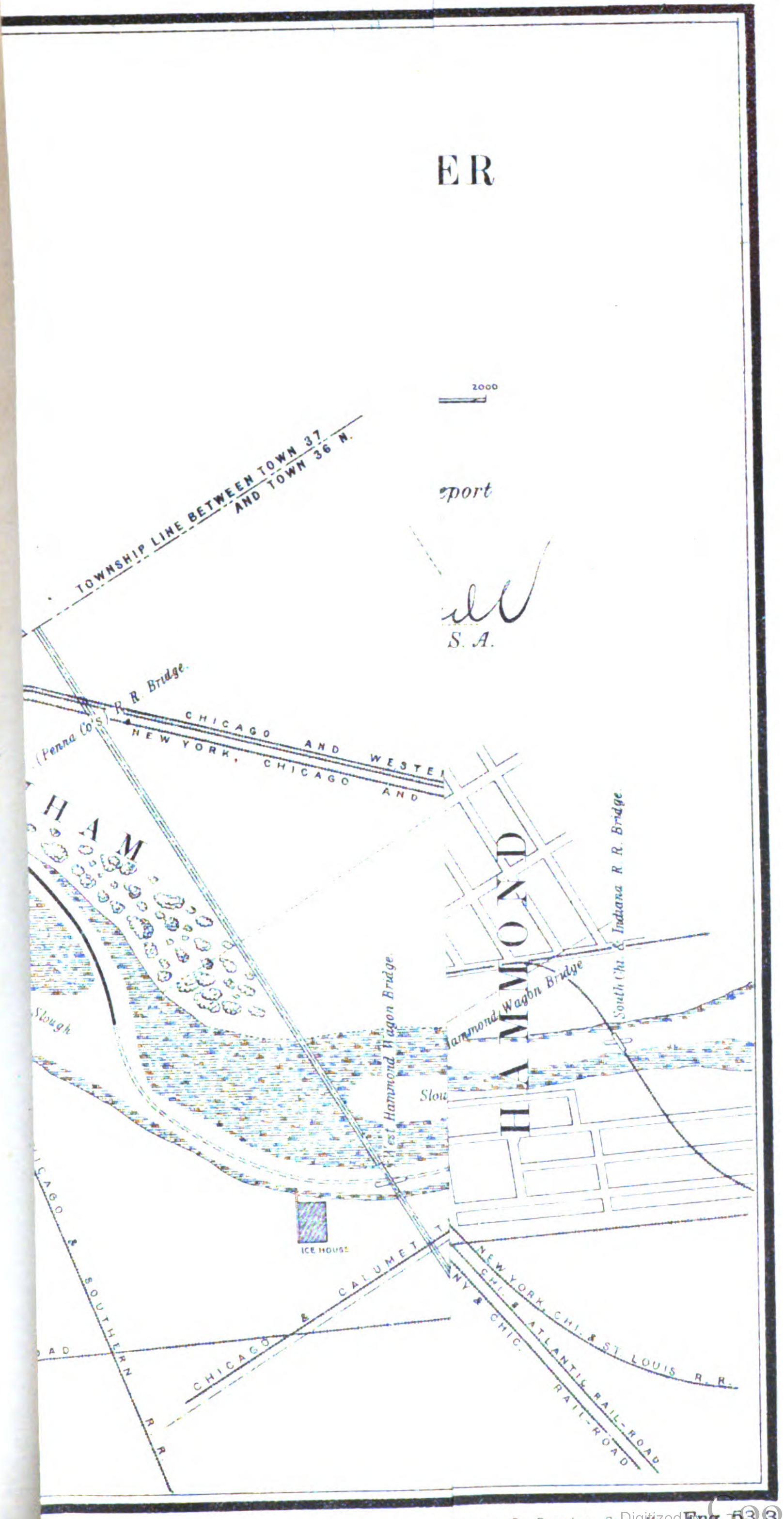
PRESENT CONDITION OF THE RIVER.

There is at present a 17-foot channel from the harbor and up to the three railway bridges, and with the work now in progress it is expected to extend this channel, with a width of about 100 feet, to the Chicago Ship-Building Company's slips, and farther if the available funds will allow. Above the shipyard only a 13 to 14 foot channel can be counted on up to One hundred and tenth street, from which place a

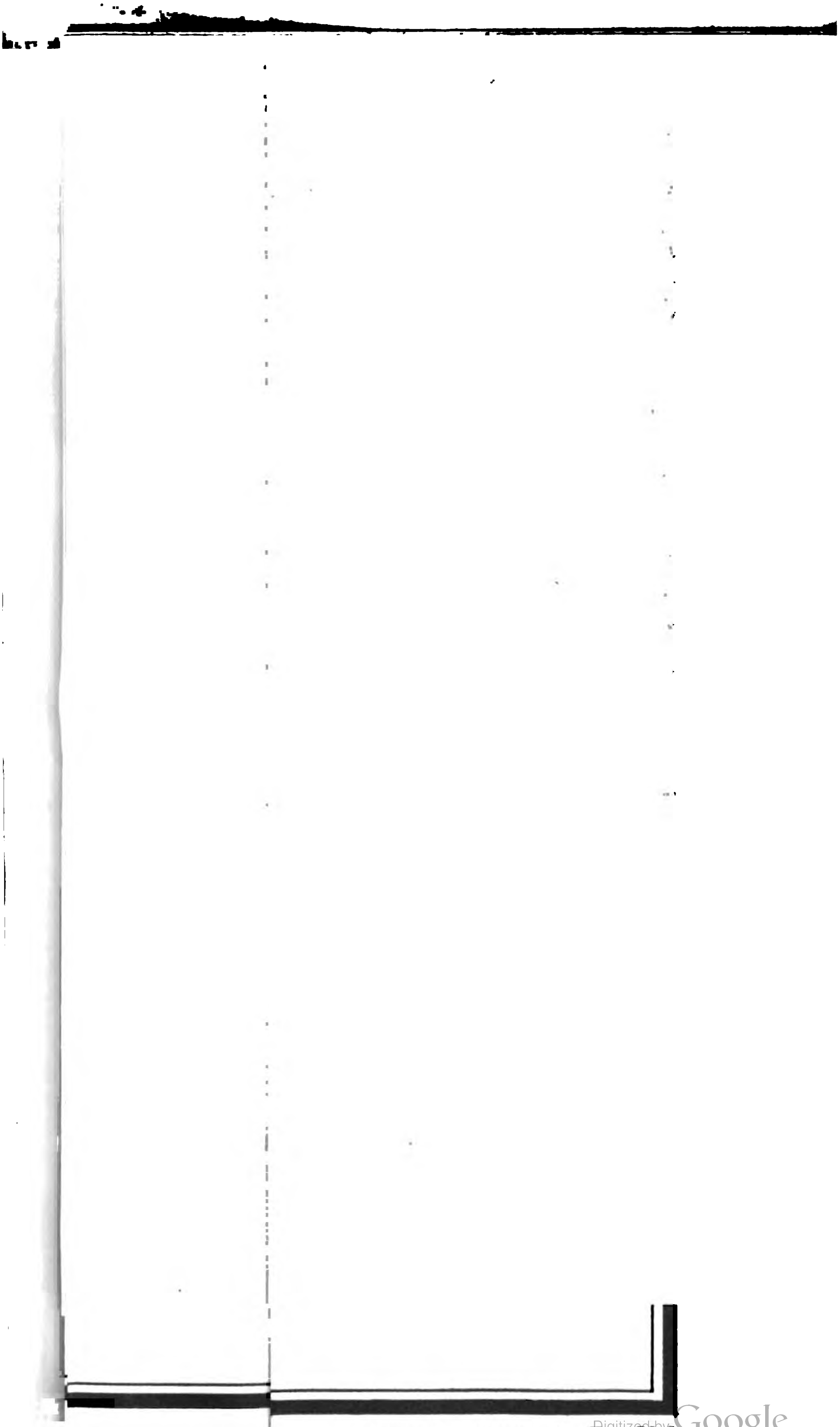
Adjust Cradle Gap
Measure Binding
SCALED RULER FOR MOVING CRADLE → SCALE



The Friedenwald Co., Photo-Lith., Balto., Md. Eng. 53 8.


ER
2000
TOWNSHIP LINE BETWEEN TOWN 37 AND TOWN 36 N.
eport
S. A.
(Penna Co's) R. R. Bridge.
CHICAGO AND WESTE
NEW YORK, CHICAGO AND
HAM
HAMMOND
South Chi. & Indiana R. R. Bridge
Hammond Wagon Bridge
West Hammond Wagon Bridge
Slough
Slou
ICE HOUSE
CHICAGO & CALUMET T
CHICAGO & SOUTHERN R. R.
OAD
NEW YORK, CHI. & ST. LOUIS R. R.
CHI. & ATLANTIC RAIL-ROAD
NY & CHIC. RAIL-ROAD

Wiedenbach Co. Photo-Lith. Balt. Eng. 53 3.



The Friedenwald Co., Photo-Lith. Balto., Md.

Eng. 53 3.

good 16-foot channel will be found up to One hundred and eighteenth street, the terminus of the year's dredging, with the exception of the place near One hundred and twelfth street, where a ledge of rock and hardpan was allowed to remain, and where there is a deep channel only at the westerly side of the river.

Above the forks there is a good 10-foot channel from the forks to the Dutchman's Slough at the town of Bernham, though this will be of but little value as long as the river below, between the Western Indiana Railroad bridge and the forks, has a channel of hardly more than 6 feet.

PROPOSED NEW WORK.

The river and harbor bill now before Congress provides for an appropriation of $45,000 for the improvement of the river, with the proviso that $10,000 out of this amount shall be expended between the forks and one-half mile east of Hammond, Ind.

It is proposed to expend the amount available for work below the forks, if the present river and harbor bill becomes a law, in redredging the part of the river which was previously dredged, but since shoaled up, so as to secure a uniform depth of not less than 16 feet below Chicago city datum.

Above the forks it is proposed, provided as above, to continue with improvement of the channel eastward toward Hammond, Ind., and as far as funds will allow.

NEW IMPROVEMENTS AND ENTERPRISES ALONG THE RIVER.

Considerable activity has been shown in the river region during the year, in spite of the hard times.

This region, with the best possible facilities for communication with the Great Lakes via the river, and with the interior of the country through the numerous railroads concentrated here, is a locality peculiarly well adapted for grain elevators. That this fact has been recognized is well demonstrated by the number of this class of structures erected and projected during the year as accounted for below.

Among new enterprises, or improvements in older ones, during the year the following are the most prominent:

1. The South Chicago elevators at the foot of Ninety-third street in South Chicago. One of these was built in 1892 and was spoken of in the report for that year. It is located on the north side of the company's private slip. Another and larger elevator has been completed during the year on the south side of the slip, which slip has been made wider at the mouth and dredged to a depth of 18 to 20 feet.

This new elevator has a capacity of 1,500,000 bushels, a ground size of 98 by 338 feet, and a height, above datum, of 161 feet. A separate pumping system with ground mains has been put in with Niagara hydrants, capable of throwing 3,000 gallons of water per minute in streams of from 2¼ to 4 inches. The elevator will have a handling capacity of 300 cars a day and a shipping capacity of 200,000 bushels.

2. The E. L. Hedstrom & Co.'s coal yard, about opposite the elevators, has had its capacity increased 50 per cent.

They handle from 25,000 to 40,000 tons of anthracite coal per month, which is brought by water. Their storage capacity is 45,000 tons. They use the best kind of machinery, and can unload, on an average, 1,600 tons per day of ten hours from vessels.

3. The Chicago Ship-Building Company, between One hundred and first and One hundred and second streets, has completed in May this year another steel freight steamer, 345 by 44 by 28 feet, at a cost of $175,000, and has now under construction a small steel dump scow to cost about $8,000.

Their dry dock, spoken of in last year's report, is not yet completed.

4. The Chicago O'Neill Grain Company has lately commenced the construction of a grain elevator 98 by 143 by 145 feet high, with a capacity of 750,000 bushels, which is expected to be ready for use on September 1 of this year. It is located on Dock No. 4 at Slip 2 of what used to be called the South Chicago Dock Company's property. The company has purchased the land on which this elevator is located and intend to erect thereon, the coming year, another elevator with a capacity of 1,500,000 bushels. This company owns about 225 elevators and warehouses in Iowa, Minnesota, the Dakotas, Wisconsin, and Illinois, and do an enormous transfer and storage business. Their land on the Calumet extends 1,625 feet along the slip and has a river frontage of 375 feet.

5. Across the slip the construction of another large elevator is under way, but information about the same, though asked for, has not been obtained.

6. The Elgin, Joliet and Eastern Railroad, known as the "Outer Belt Line," has planned a number of new elevators and warehouses to be erected in this locality in the near future.

7. The Compound Lumber Company, on the Grand Calumet River at the town of Burnham, has consumed about 1,000,000 feet, B. M., of lumber, mostly hardwood, in their mill during the year.

Owing to the hard times, they have not worked to full capacity this year.

They complain of the pollution of the river water from Hammond slaughterhouses and also express a desire to secure a navigable channel up to their works, as they wish to be able to get their lumber by water.

The following maps are respectfully submitted with this report:

1. General map of river below the forks.
2. General map of river above the forks.
3. Map showing result of dredging below the forks.

Mr. Stephan Creutz has acted as inspector of the work below the forks, and Mr. Alb. Ackander as inspecter at work above the forks. Both have performed their duties faithfully.

I am, captain, very respectfully, your obedient servant,

G. A. M. LILJENCRANTZ,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

As the Calumet River and harbor are so closely connected in their commercial relations, no commercial statistics are given in this place, but will be found under the head of Calumet Harbor. There is practically no navigation on the river beyond that at the harbor. As soon, however, as the river channel is opened by dredging, navigation and business along the river will develop very fast. It awaits only this opening.

K K 4.

IMPROVEMENT OF ILLINOIS RIVER, ILLINOIS.

The ultimate object of this improvement is to furnish a through route of transportation by water from the southern end of Lake Michigan to the Mississippi River, of sufficient capacity for the navigation by the largest class of Mississippi River steamboats that can reach the mouth of the Illinois River.

The dimensions that have been adopted for the locks to meet this requirement are:

	Feet.
Length of lock chamber	350
Width of chamber	75
Depth at low water over sills	7

The project now under execution is for the improvement of the lower section of this route, extending from the mouth of Copperas Creek to the Mississippi River, a distance of 137 miles. Another section of the river, 88 miles in length, from the mouth of Copperas Creek to La Salle, has been improved by the State of Illinois by the construction of two locks and dams, one at Copperas Creek and one at Henry, Ill.

Over this latter section the State still collects tolls, the United States not yet having accepted the conditions imposed by the act of cession of the Illinois legislature, which conditions, if accepted, are such as would deprive the works of all value, while demanding a great expenditure by the U. S. Government for works to be substituted therefor.

With regard to this subject, reference is made to the Annual Report of the Chief of Engineers for 1889, p. 2121, *et seq.*

Under the act of Congress of August 11, 1888, surveys and separate estimates have been made, based upon low-water depths of 8 and 14 feet, for carrying the improvement from La Salle to Lake Michigan, via the Illinois and Desplaines rivers, and a cut across the Chicago divide, over which section there is a fall in water surfaces, Lake Michigan being the summit, of about 141 feet.

The report upon this survey and estimates has been printed as House Ex. Doc. No. 264, Fifty-first Congress, first session, and is also published in the Annual Report of the Chief of Engineers for 1890, p. 2419 and following pages.

In the reports named above and in the Annual Reports of the Chief of Engineers, U. S. Army, for the fiscal years 1891, 1892, and 1893, and in the various reports and estimates made by authority of the trustees of the sanitary district of Chicago, organized under the laws of the State of Illinois, full information relating to the objects and expected results of this improvement, and discussions of correlated improvements by local authority, may be found.

The existing project involves the construction of two locks and dams in the Illinois River, one at La Grange, 79 miles, and the other at Kampsville, 31 miles above the mouth of the Illinois, and dredging the channels from the mouth of Copperas Creek to the Mississippi River, a distance of 137 miles, to give 7 feet depth at low water over bars. More than 2,000,000 cubic yards of dredging in this section is required.

The reach, 88 miles in length, between La Salle and Copperas Creek, also requires dredging to carry the channel from La Salle to the Mississippi River.

As far as the construction of locks and dams are concerned, the project is practically completed and in use. The dredging remains to be done, and an efficient snagging service provided.

The depths of navigation under this project, when attained, will meet all the requirements of navigation by Western river steamboats, but until this navigation is extended to the Great Lakes at the southern end of Lake Michigan the improvement will be of comparatively small value.

Congress has so far made no provision for extending the navigation on the same or equivalent basis from La Salle to Lake Michigan, although repeated surveys and estimates have been made. It is now apparently necessary to consider the question of this extension and the relation thereof to the State works now existing or in process of construction.

Up to this time no satisfactory basis for the transfer of the State works of navigation has been presented by the Illinois authorities.

During the past fiscal year the Kampsville dam, 1,200 feet in length, 7.4 feet head at low water, was constructed, the maneuvering gear of the lock placed, the cofferdam removed, and the lock opened for navigation.

The revetment at the head of the lock was completed, guide piles placed, and part of the revetment below the abutment of the dam constructed.

The method of building dams on soft foundation, first applied at La Grange Lock in 1889, was improved and applied at Kampsville with gratifying success, and the dam speedily constructed at small cost.

The report hereto attached of Assistant Engineer C. V. Brainard gives details of the work.

The large amount of dredging still to be done will require a renewal of the hulls of the dredges now owned by the United States and a further increase in the dredging plant. The work which could have been done in three years with adequate appropriations has been extended over fourteen years, necessitating an excessive expenditure for maintenance of plant and property and large expenditures for removal, again and again, of sediment deposited about unfinished works. The consequence is that the balance of the estimate for the completion of that part of the Illinois River improvement assumed by Congress is insufficient to complete the dredging.

It is now necessary to consider the extension of the improvement from La Salle to Lake Michigan, a necessary preliminary to which work is the possession by the United States of the improvements made over parts of the line by the State of Illinois. Up to this date the Illinois legislature has proposed no practicable basis for the transfer of this property, but has exhibited a tendency to dictate the character of the improvement to be made by the General Government in such terms as to make the State works valueless as forming part of the works of navigation along the improved channel.

The dams at Henry and Copperas Creek have been directed removed by the legislature of Illinois, but one year after the date set for removal they still exist. The dam at Henry maintains a pool in the Illinois River that for 14 miles forms practically a part of the Illinois and Mississippi Canal, and is essential to the success of that work. The acts of the Illinois legislature constantly menaces the existence of this dam as well as of Copperas Creek dam, and it is advisable, under every aspect of the question, to prevent the removal of these structures until the levels in the Illinois River are produced and maintained by equivalent means. The surest way to effect this end, as well as to enable the United States to extend the steamboat channel to Lake Michigan, is to secure the State works on the Illinois River by condemnation if they can not be obtained from the State by legislative transfer.

Money statement.

July 1, 1893, balance unexpended		$76,844.14
June 30, 1894, amount expended during fiscal year	$69,745.12	
August, 1893, amount refunded Capt. Marshall account erroneous deposit, 1892	5.50	
		69,750.62
July 1, 1894, balance unexpended		7,093.52
July 1, 1894, outstanding liabilities		1,697.28
July 1, 1894, balance available		5,396.24
Amount (estimated) required for completion of existing project		112,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		112,500.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1836 and 1867 and of sundry civil act of March 3, 1893.

Disbursements fiscal year 1894.

La Grange Lock	$907.24
Kampsville Lock	12,406.11
Kampsville Dam	33,886.29
Contingencies	1,115.86
Operating expenses	7,842.90
Care of property	1,635.14
Plant and repair of plant	11,951.58
Total	69,745.12

REPORT OF MR. C. V. BRAINARD, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., *June 30, 1894.*

CAPTAIN: I have the honor to submit the following report upon improving the Illinois River for the fiscal year ending June 30, 1894:

The work consisted of the completion of the dam, removing the cofferdam, and opening the lock to navigation by dredging the approaches thereto. In addition, the floating plant was kept in a serviceable condition by making minor repairs, and at the end of the season the two dredges, one steamboat, and the office boat were hauled out and thoroughly repaired.

The season was admirable for building the dam. Early in August the river fell to nearly low water and shortly afterwards to extreme low water and remaining so until October, after the completion of the dam.

At the beginning of the fiscal year active work was in progress getting plant ready, building track and trestles for handling the rock filling, and other preparatory work.

There had been completed the lock walls, gates, and the east abutment. In the dam the piles had been driven and braced and the dam completed up to a foot below low water for a distance of 258 feet from the east abutment.

The dam is 1,200 feet long, 7 feet and 4 inches above low water, and is of the same type as the one at La Grange Lock, Illinois River, plans for which are shown complete opposite p. 2122 Report of Chief of Engineers for 1889, except that the horizontal wale extending up and down stream is omitted and the sheet piling is in two lengths instead of one, the lower section coming up to low water and the other to the top of the dam and lapping down over the lower. The sheet piling used was the "Wakefield triple lap" and made of 2 by 12 inch by 16-foot oak. The piles differ from the ordinary "Wakefield" in that they are put together with 14 wrought spikes $\frac{5}{16}$ by 6½ inches, driven through and clinched instead of being bolted. It was found that this fastening would stand all the driving the planks themselves would and they were much more rapidly made, as no boring was necessary except for the end spikes.

The sheet piles were driven with an ordinary friction-hoist pile-driver, the hammer weighing 3,500 pounds. A fall of 3 or 4 feet for the hammer, the strokes being delivered as rapidly as possible, was found to be the most satisfactory way of driving them. Various devices were used on the different drivers for holding the head, the point being driven in any desired position by the proper sharpening.

METHOD OF CONSTRUCTION.

The round piles were first driven, the slanting and lower front wales bolted on, the latter being put a little below the water surface. While this work was being done rubble was put in around the piles to prevent any scour due to the contraction of the channel, enough being put in to thoroughly cover the bottom of the river. When the round piles were all driven and the framing far enough along to keep ahead of the sheet piling, driving the lower row of sheet piles was begun. Four drivers were used working sixteen hours per day in two shifts, closing this row of 810 piles in sixty-four hours. As soon as driven, earth filling was banked to the top of them. This row was driven a few inches below the water surface, that the water might discharge over the top of it with as little head as possible, that the scouring action in closing might be as small as possible. The valves in the lock were all open to assist in keeping the head down. In fact, no scour of the bed of the river could be discovered at any time during the driving of these sheet piles. During this time and until the completion of the dam the rock ballast was put in as rapidly as possible.

Planking was then temporarily put on the face of the dam to raise the water enough to allow the use of the lock. The second row of sheet piling, reaching to the top of the dam, was driven as soon as possible, being completed September 1. The water in the pool was then allowed to rise to within about a foot of the top of the dam and kept from running over by passing the discharge through the valves of the lock, which are capable of taking care of the low-water discharge, until the completion of the dam September 30.

There was 11,795 cubic yards of rock ballast put in and below the dam, it extending 20 feet downstream from the dam up to low water for the whole length of the dam. This rock was towed to the upper side of the dam on barges and thrown in, care being taken to pack it well around the timbers. For loading it upon the barges a trestle was built out into the river with a span through which the barges could be worked. About 2,000 feet of double-track railroad was laid upon which was used ten 1¼ cubic-yard side-dump cars. These cars when loaded were run out on the trestle and dumped on the barges. In this way about 300 cubic yards per day could be put in the dam with from 60 to 70 men and 2 teams.

The first work of the season, pile-driving on the dam, began July 19. August 10 the river was closed to navigation. August 29 the first boat passed through the lock, being one of the boats engaged upon the work, and September 30 the dam was completed.

DREDGING.

The dredging consisted of 10,303 cubic yards scowed away, and one hundred and fifty hours casting in opening the cofferdam on the site of the dam, dredging above and below the east abutment for the pile revetments, filling above the dam, and dredging at the railroad slip. The earth filling above the dam was completed to within from 2 to 3 feet of the top.

REVETMENTS.

Two pile revetments were built on the east side of the river, one 50 feet long above and the other 150 feet long below the abutment. Two thousand three hundred and thirty-nine cubic yards of earth filling was put in back of the revetments, around the abutment, and in a levee running directly back from the abutment 400 feet, with its top 17 feet above low water. Six hundred and two cubic yards of rock was used to riprap the slopes of the levee and about the abutment.

A detailed statement of the cost of the dam is herewith.

KAMPSVILLE LOCK.

During July and August the water was pumped out of the lock pit and the mud cleaned away from around the gates and off the head-bay platform. The gates were decked with 1-inch pine flooring, two spar-track platforms built from the river wall, and the gate maneuvering gear put in place. Five thousand one hundred and fifty-seven cubic yards of earth filling was put behind the land wall, completing the filling the entire length and to the top of the wall. A grand total of 50,521 cubic yards of earth has been placed behind this wall.

As the water went down the earth filling put behind the land wall with scows during the high water was of such a semifluid character that both wing walls were forced out and a crack 1¼ inches wide made the whole height of the walls. The filling was excavated the whole length of the wing walls to low water, and a dry rubble wall 12 feet wide was built back of them their whole length and to within 14 inches of the top. The cracks were well cleaned out and filled with Portland cement mortar well rammed. No signs have since been discovered of any further failure.

A crib revetment 150 feet long, 18 feet wide, and to a height of 14.5 feet above low water was built from the upper end of the land wall upstream along the bank. The crib work was built upon piles driven 1 foot below low-water surface of the upper pool. Sheet piling were driven in the lower part to retain the bank and the crib filled with rock. Four clumps of 7 piles each were driven along the face of the revetment to serve as guide piles, their tops being the same height as the upper end of the lock wall. Four clumps, extending 150 feet above the river wall, one above the outer end of the upper spar track platform and one at the lower end of the river wall, were driven. These all have 7 piles each, with the tops drawn together, chained, and bolted. A single row of 11 piles was driven from the upper end of the river wall to the outer end of the upper spar track platform, and wales were bolted on at the top and just above low water.

The lock was opened to navigation by dredging from the approaches 20,196 cubic yards of earth, casting on the bank seventy hours, and pulling 9 piles.

PLANT.

Two new barges 16 by 50 by 3½ feet were built of material from the traveler trestles, to be used as pile-driver flats. Also two small flats 6 by 20 feet for ferrying men across the river.

A set of ways was put in after the season's work was done, and both dredges, steamer *Enterprise*, and the office boat were pulled out and given a thorough repair.

Steamer Enterprise.—This boat had the roof recanvased, two-thirds of the decking renewed, 100 linear feet of new 4 by 12 inch plank in the sides, 17 new deck beams, new bridgetree and transom, 80 linear feet of 2 by 10 inch oak plank shear, the wheel shafting lined, the boxings babbitted, and the capstan overhauled. One thread of old oakum was reefed out of the bottom and sides and a new thread made in.

Steamer Hebe.—A new breeching was put on the boiler and new slide brasses for main engines. The boat was given one coat of paint outside.

Dredge No. 1.—A set of new dipper arms, one new spud, new tubes in the heater, roof recanvased, 6 new rake timbers, 28 stanchions, 29 deck beams, one set of spud casings at bow and one at stern, 800 square feet of 2-inch pine decking, new head-block 6 by 14 inches by 28 feet at the stern, 140 linear feet of 3 by 10 inch oak nosing, one thread of oakum reefed out of seams, all seams of the bottom and sides recalked with two threads and the deck with one were the repairs to this dredge.

Dredge No. 2.—The work done on this dredge was 40 new deck beams, 28 new stanchions, about three-fourths of the sides renewed, 5 new rake timbers, 8 new plank in the bottom, new decking entire, two sets of spud casings in front, 145 linear feet of 3 by 10 inch oak nosing, two threads of oakum in all the seams of the bottom, three in the new work on the sides, and one on the deck, 8 new tubes in the boiler, the roof recanvassed and painted, and the cabin painted inside.

Office boat.—The following is the work done on this boat: New stem for each end, new hood ends, 53 new futtocks, 15 pieces of floor timbers, 48 new top timbers, 2 new deadwoods, grubstrakes and knucklestrakes renewed, 20 pieces of new plank in the bottom, all seams calked with one thread of oakum, 2 new chimney jacks, and the roof recanvassed and painted.

Dump scows.—Three new gates were made and hung.

Miscellaneous.—Four barges, three sets of pile-driver leads with the engines and cabins, pumping engines, travelers, and the rock crusher were all painted.

BUILDINGS AND GROUNDS.

The United States land on the east side of the river was surveyed, the corners marked, and the land fenced. A small building, 14 by 18 feet, was built for use as a bakery. The buildings and fences were all whitewashed.

IMPROVING ILLINOIS RIVER BELOW KAMPSVILLE LOCK.

During the month of June, 1894, surveys were made of Hurricane Island and French bars, the first two below Kampsville Lock, and a project submitted for the improvement of the one at Hurricane Island, contemplating a channel with a least depth of 4 feet and a width of 150 feet. The work involved the straightening of the channel through the bar for a distance of 500 feet. This has been accomplished by the removal of 4,200 cubic yards of dirt.

Very respectfully, your obedient servant,

C. V. BRAINARD,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Detailed statement of the cost of Kampsville Dam.

	Quantity.	Cost per unit.		Amount.
		Unit.	Cost.	
Abutment.				
Labor				$2 262.16
Material including stone, piles, etc				3,237.26
				5,499.42
Dam, labor, including subsistence.				
Dredging				3,144.66
Earth filling ... cubic yards	3,332	Cubic yard	$0.17	566.44
Ballasting with rock* ... do	11,795	do	.404	4,761.30
Framing lumber† ... feet, B. M	313,212	Per M	13.23	4,140.96
Driving piles, round ... number	1,104	Each	1.54	1,701.62
Driving piles, sheet ... do	2,600	do	.482	1,253.58
Making piles, sheet ... feet, B. M	235,463	Per M	1.83	432.00
Making piles, sheet ... number	2,600	Each	.166	
Transferring coal and ice				81.25
Care and repair of plant				203.74
Care of buildings and grounds				105.58
				16,393.53
Dam, material.				
Coal				1,276.72
Oil, coal and lubricating				127.64
Piles, round (1,271-28 feet; 120-18 feet) ... number	1,391			4,128.47
Lumber;				
Oak ... feet, B. M	302,136			9,482.93
Pine ... do	74,891			1,408.14
Oregon fir ... do	171,648			4,377.02
For bakery				53.06
Rubble ... cubic yards	11,795			10,615.59
Iron, bolts, etc				1,080.82
10 dump cars				810.00
Augers, files, rope, dishes, etc				817.81
				34,178.11
Total				56,071.06

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* Includes laying track and dumping platform.
† Includes all transferring lumber from railroad.

Readings of the upper gauge at Copperas Creek Lock, 1893.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	12.00	11.70	17.97	19.00	20.07	17.22	13.65	11.35	11.15	11.50	11.60	11.60
2	12.00	11.70	18.20	18.93	20.10	17.13	13.63	11.35	11.20	11.50	11.60	11.60
3	11.90	11.71	18.63	18.77	20.18	17.04	13.42	11.35	11.20	11.50	11.60	11.60
4	11.90	11.80	18.93	18.53	20.13	17.00	13.20	11.35	11.20	11.55	11.60	11.60
5	11.90	11.80	19.10	18.40	20.03	16.93	13.00	11.35	11.20	11.55	11.60	11.60
6	11.90	11.80	19.20	18.13	20.00	16.85	12.85	11.35	11.25	11.60	11.60	11.60
7	11.90	11.80	19.20	17.97	20.00	16.75	12.78	11.35	11.25	11.60	11.60	11.60
8	11.90	11.77	19.37	17.60	19.87	16.60	12.62	11.30	11.30	11.60	11.60	11.60
9	11.90	11.80	20.27	17.40	19.80	16.45	12.48	11.30	11.30	11.60	11.60	11.60
10	11.83	11.80	21.10	17.30	19.70	16.25	12.42	11.30	11.32	11.55	11.60	11.80
11	11.80	11.80	21.73	17.07	19.63	16.15	12.22	11.30	11.30	11.60	11.60	11.80
12	11.80	11.80	22.50	17.00	19.50	16.00	11.98	11.30	11.35	11.65	11.50	11.80
13	11.80	12.03	22.80	17.00	19.50	15.93	11.88	11.30	11.35	11.70	11.50	11.80
14	11.80	12.67	22.80	16.93	19.40	15.80	11.80	11.25	11.35	11.70	11.50	11.80
15	11.80	13.73	22.00	16.80	19.40	15.80	11.78	11.25	11.30	11.60	11.50	11.80
16	11.75	14.53	21.63	16.70	19.33	15.72	11.75	11.25	11.30	11.60	11.50	11.80
17	11.70	15.30	21.40	16.62	19.17	15.70	11.75	11.20	11.30	11.60	11.50	12.00
18	11.70	15.97	21.03	16.43	18.97	15.55	11.75	11.20	11.30	11.60	11.50	12.00
19	11.70	16.27	20.80	16.43	18.70	15.45	11.75	11.20	11.30	11.60	11.60	12.00
20	11.70	16.50	20.40	16.93	18.53	15.25	11.75	11.20	11.30	11.60	11.60	12.00
21	11.70	16.77	20.20	17.30	18.38	15.00	11.70	11.20	11.35	11.60	11.60	12.00
22	11.70	17.10	20.03	17.70	18.27	14.88	11.70	11.15	11.40	11.60	11.60	12.00
23	11.70	17.20	19.73	18.00	18.15	14.80	11.65	11.10	11.45	11.60	11.60	12.00
24	11.70	17.30	19.70	18.40	18.00	14.75	11.60	11.10	11.50	11.60	11.60	12.20
25	11.70	17.37	19.57	18.60	17.82	14.65	11.55	11.10	11.50	11.60	11.60	12.20
26	11.70	17.43	19.40	18.90	17.77	14.50	11.50	11.10	11.40	11.60	11.60	12.20
27	11.70	17.47	19.32	19.20	17.80	14.35	11.50	11.10	11.40	11.60	11.60	12.20
28	11.70	17.67	19.23	19.50	17.65	14.15	11.50	11.10	11.45	11.60	11.60	12.20
29	11.70	......	19.20	19.70	17.48	13.93	11.50	11.10	11.45	11.60	11.60	12.20
30	11.70	......	19.10	19.87	17.35	13.78	11.45	11.15	11.40	11.60	11.60	12.20
31	11.70	......	19.03	......	17.30	......	11.40	11.15	......	11.60	11.60	12.20
Mean	11.79	14.16	20.12	17.90	18.97	15.68	12.11	11.23	11.33	11.59	11.58	11.89

Readings of the lower gauge at Copperas Creek Lock, 1893.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	9.00	8.80	17.80	18.73	20.00	16.93	13.37	7.35	6.35	7.05	7.50	7.60
2	8.90	8.80	18.03	18.63	20.00	16.87	13.20	7.35	6.40	7.10	7.50	7.60
3	8.90	8.90	18.37	18.47	20.07	16.73	12.90	7.35	6.40	7.25	7.50	8.00
4	8.90	8.90	18.70	18.17	20.07	16.70	12.60	7.35	6.40	7.30	7.50	8.00
5	8.90	8.90	18.90	17.90	19.93	16.60	12.30	7.35	6.40	7.30	7.50	8.00
6	8.90	8.90	18.97	17.53	19.90	16.57	12.10	7.35	6.50	7.35	7.50	8.00
7	8.90	8.92	19.10	17.37	19.80	16.43	11.90	7.28	6.60	7.40	7.50	8.00
8	8.90	9.00	19.30	17.10	19.77	16.35	11.77	7.18	6.70	7.40	7.50	8.00
9	8.90	9.10	20.07	17.00	19.70	16.17	11.53	7.09	6.70	7.40	7.50	8.90
10	8.80	9.00	20.90	16.93	19.57	15.97	11.40	6.98	6.70	7.30	7.50	8.00
11	8.80	9.00	21.53	16.60	19.43	15.80	11.23	6.88	6.70	7.42	7.50	8.00
12	8.80	9.00	22.30	16.63	19.30	15.70	10.63	6.79	6.70	7.45	7.50	8.90
13	8.80	9.43	22.60	16.70	19.30	15.63	10.25	6.65	6.70	7.50	7.50	8.00
14	8.80	11.40	22.60	16.64	19.10	15.50	10.08	6.60	6.70	7.50	7.50	8.00
15	8.80	13.10	21.80	16.50	19.10	15.50	9.80	6.55	6.60	7.45	7.50	8.00
16	8.80	14.20	21.43	16.50	19.00	15.40	9.60	6.55	6.60	7.45	7.50	8.00
17	8.80	14.90	21.20	16.40	18.80	15.40	9.45	6.50	6.60	7.50	7.50	8.40
18	8.80	15.57	20.83	16.23	18.67	15.20	9.30	6.50	6.60	7.50	7.50	8.40
19	8.85	16.03	20.60	16.20	18.40	15.07	9.13	6.50	6.55	7.50	7.60	8.40
20	8.90	16.30	20.17	16.63	18.23	14.98	8.90	6.50	6.60	7.50	7.60	8.40
21	8.90	16.60	19.90	17.00	18.10	14.80	8.70	6.50	6.60	7.50	7.60	8.50
22	8.90	16.90	19.73	17.40	18.07	14.67	8.50	6.45	6.70	7.50	7.60	8.50
23	8.90	17.00	19.43	17.67	17.90	14.50	8.30	6.40	6.80	7.50	7.60	8.50
24	8.90	17.17	19.40	18.07	17.67	14.43	8.08	6.35	7.00	7.50	7.60	9.00
25	8.90	17.23	19.27	18.43	17.53	14.37	7.83	6.35	6.90	7.50	7.60	9.00
26	8.90	17.37	19.10	18.80	17.50	14.15	7.62	6.30	6.90	7.50	7.60	9.00
27	8.90	17.42	19.10	19.10	17.50	13.97	7.60	6.30	7.00	7.50	7.60	9.00
28	8.90	17.56	19.03	19.40	17.37	13.78	7.53	6.30	6.90	7.50	7.60	9.00
29	8.90	......	19.00	19.60	17.20	13.53	7.50	6.30	7.00	7.50	7.60	9.00
30	8.90	......	18.90	19.80	17.07	13.50	7.45	6.35	6.95	7.50	7.60	9.00
31	8.90	......	18.83	......	17.00	......	7.40	6.35	......	7.50	......	9.00
Mean	8.87	12.69	19.90	17.60	18.74	15.37	9.93	6.73	6.67	7.42	7.54	8.33

Readings of the upper gauge at La Grange Lock, 1893

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	15.40	15.25	21.57	21.85	24.42	22.00	17.37	15.40	14.95	(*)	15.05	15.10
2	15.35	15.25	21.53	21.65	24.75	22.25	17.28	15.35	14.95	(*)	15.05	15.10
3	15.35	15.30	21.58	21.50	24.80	22.32	17.15	15.30	14.95	(*)	15.05	15.10
4	15.35	15.30	21.65	21.30	24.80	22.25	16.95	15.27	14.95	(*)	15.05	15.10
5	15.35	15.32	21.60	21.10	24.80	22.05	16.75	15.25	14.95	(*)	15.05	15.12
6	15.35	15.40	21.60	20.90	24.75	21.85	16.47	15.20	14.95	(*)	15.05	15.15
7	15.30	15.40	21.75	20.70	24.67	21.63	16.25	15.20	14.95	(*)	15.05	15.15
8	15.30	15.40	22.45	20.53	24.63	21.32	16.40	15.15	15.00	15.05	15.05	15.15
9	15.30	15.40	23.00	20.45	24.50	21.05	16.83	15.15	15.00	15.10	15.05	15.15
10	15.25	15.45	23.40	20.40	24.40	20.85	16.77	15.15	14.97	15.10	15.05	15.15
11	15.25	15.45	23.65	20.37	24.07	20.60	16.60	15.15	14.90	15.15	15.05	15.20
12	15.25	15.50	23.80	20.35	23.93	20.50	16.48	15.10	14.90	15.20	15.05	15.23
13	15.25	15.57	23.85	20.28	23.67	20.25	16.37	15.10	14.90	15.20	15.10	15.25
14	15.25	16.20	23.87	20.17	23.40	20.05	16.28	15.10	14.90	15.20	15.10	15.27
15	15.25	17.25	23.83	20.03	23.20	19.95	16.17	15.07	14.90	15.20	15.10	15.33
16	15.25	18.50	23.65	20.00	22.90	19.67	16.08	15.05	14.90	15.20	15.10	15.35
17	15.20	19.17	23.45	20.00	22.70	19.38	15.97	15.05	14.90	15.20	15.10	15.37
18	15.20	19.70	23.23	20.05	22.50	19.13	15.85	15.05	14.90	15.20	15.10	15.35
19	15.20	19.92	23.10	20.25	22.33	18.87	15.80	15.00	14.90	15.15	15.10	15.38
20	15.20	20.25	22.85	20.45	22.20	18.65	15.77	15.00	14.95	15.15	15.10	15.45
21	15.20	20.80	22.73	20.72	22.00	18.47	15.68	14.95	15.00	15.10	15.12	15.45
22	15.20	21.25	22.62	21.05	21.70	18.30	15.65	14.93	15.00	15.10	15.13	15.45
23	15.20	21.40	22.50	21.15	21.40	18.13	15.60	14.90	15.00	15.10	15.10	15.45
24	15.20	21.47	22.50	21.30	21.20	17.97	15.60	14.90	15.02	15.10	15.10	15.47
25	15.20	21.60	22.50	21.65	21.00	17.83	15.60	14.92	15.00	15.10	15.10	15.50
26	15.25	21.57	22.50	22.17	21.65	17.72	15.65	14.95	15.00	15.10	15.10	15.50
27	15.25	21.58	22.50	22.60	22.13	17.58	15.65	14.95	15.00	15.05	15.10	15.55
28	15.25	21.77	22.43	23.15	22.02	17.43	15.57	14.95	15.00	15.05	15.10	15.55
29	15.25	....	22.32	23.67	21.90	17.40	15.53	14.95	(*)	15.05	15.10	15.55
30	15.25	....	22.23	24.10	21.70	17.40	15.47	14.95	(*)	15.05	15.10	15.58
31	15.25	....	22.05	....	21.70	....	15.43	14.95	....	15.05	....	15.60
Mean ..	15.26	17.94	22.65	21.13	23.09	19.76	16.16	15.08	14.95	15.12	15.08	15.33

* Valves open. No records taken.

Readings of the lower gauge at La Grange Lock, 1893.

[Plane of reference: Lower miter sill.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	9.80	9.50	21.30	21.65	24.20	21.77	14.80	8.35	7.10	(*)	8.10	8.20
2	9.80	9.57	21.35	21.45	24.55	22.05	14.55	8.35	7.10	(*)	8.10	8.20
3	9.75	9.63	21.33	21.30	24.60	22.13	14.25	8.30	7.10	(*)	8.10	8.10
4	9.73	9.75	21.37	21.07	24.60	22.05	13.97	8.25	7.10	(*)	8.10	7.95
5	9.70	9.95	21.30	20.85	24.60	21.85	13.68	8.20	7.10	(*)	8.10	8.15
6	9.65	10.15	21.30	20.58	24.55	21.65	13.37	8.15	7.13	(*)	8.05	8.45
7	9.62	10.27	21.35	20.35	24.57	21.37	13.08	8.10	7.17	(*)	8.00	8.65
8	9.55	10.38	22.17	20.20	24.37	21.08	13.15	8.05	7.33	8.20	8.00	8.75
9	9.50	10.40	22.75	20.10	24.20	20.77	14.15	8.00	7.40	8.20	8.00	8.75
10	9.50	10.45	23.20	20.03	24.00	20.55	13.40	7.95	7.40	8.30	8.00	8.70
11	9.47	10.55	23.45	19.95	23.77	20.27	12.80	7.95	7.40	8.35	8.00	8.85
12	9.45	11.30	23.60	19.83	23.63	19.98	12.35	7.93	7.40	8.40	8.00	9.00
13	9.40	11.85	23.65	19.67	23.37	19.75	11.83	7.90	7.40	8.40	8.03	9.07
14	9.40	13.65	23.67	19.58	23.10	19.60	11.20	7.87	7.35	8.40	8.10	9.30
15	9.38	16.70	23.63	19.50	22.87	19.42	10.95	7.77	7.22	8.40	8.12	9.68
16	9.35	18.10	23.45	19.50	22.65	19.13	10.75	7.68	7.20	8.40	8.03	9.85
17	9.35	18.85	23.25	19.55	22.45	18.75	10.60	7.60	7.20	8.40	8.00	10.03
18	9.30	19.27	23.12	19.57	22.25	18.43	10.60	7.57	7.20	8.40	8.00	10.10
19	9.27	19.50	23.00	19.73	22.08	18.12	10.30	7.55	7.20	8.37	8.00	9.85
20	9.25	19.87	22.80	19.90	21.95	17.85	9.95	7.48	7.33	8.35	8.00	9.70
21	9.28	20.50	22.55	20.30	21.75	17.57	9.70	7.45	7.32	8.30	8.10	9.65
22	9.30	20.95	22.42	20.65	21.52	17.30	9.45	7.38	7.40	8.30	8.20	9.67
23	9.30	21.10	22.30	20.75	21.30	17.10	9.25	7.27	7.65	8.30	8.17	9.70
24	9.32	21.17	22.30	20.90	21.10	16.82	9.13	7.20	7.72	8.30	8.15	9.68
25	9.37	21.28	22.30	21.30	20.87	16.55	9.10	7.18	7.70	8.30	8.15	9.70
26	9.40	21.32	22.30	21.82	21.43	16.28	9.07	7.05	7.63	8.20	8.18	9.70
27	9.40	21.30	22.30	22.25	21.95	16.00	8.90	7.07	7.60	8.15	8.20	9.83
28	9.40	21.33	22.23	22.85	21.85	15.60	8.72	7.10	7.60	8.10	8.20	9.80
29	9.40	....	22.12	23.38	21.70	15.32	8.63	7.10	(*)	8.10	8.20	9.80
30	9.40	....	22.03	23.80	21.50	15.03	8.47	7.10	(*)	8.10	8.20	9.82
31	9.45	....	21.85	....	21.50	....	8.40	7.05	....	8.10	....	9.80
Mean ..	9.46	15.31	22.44	20.74	22.87	19.00	11.24	7.68	7.34	8.28	8.09	9.24

* Valves open. No records taken.

Readings of the upper gauge at Kampsville Lock, 1893.

[Plane of reference: Lower miter sill; 7.25 feet below low water of 1879.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	......	......	......	......	......	......	......	......	......	14.25	15.38	15.40
2	......	......	......	......	......	......	......	......	......	14.40	15.50	15.35
3	......	......	......	......	......	......	......	......	......	14.57	15.40	15.30
4	......	......	......	......	......	......	......	......	......	14.65	15.45	15.30
5	......	......	......	......	......	......	......	......	......	14.72	15.50	15.30
6	......	......	......	......	......	......	......	......	......	14.55	15.50	15.35
7	......	......	......	......	......	......	......	......	......	14.52	15.45	15.40
8	......	......	......	......	......	......	......	......	......	14.60	15.45	15.40
9	......	......	......	......	......	......	......	......	......	14.75	15.48	15.45
10	......	......	......	......	......	......	......	......	13.85	14.85	15.50	15.40
11	......	......	......	......	......	......	......	......	13.85	14.85	15.50	15.40
12	......	......	......	......	......	......	......	......	13.87	14.92	15.50	15.45
13	......	......	......	......	......	......	......	......	14.03	15.00	15.50	15.50
14	......	......	......	......	......	......	......	......	14.05	14.95	15.50	15.40
15	......	......	......	......	......	......	......	......	13.85	14.85	15.45	15.40
16	......	......	......	......	......	......	......	......	13.85	14.85	15.45	15.50
17	......	......	......	......	......	......	......	......	13.45	14.90	15.50	15.50
18	......	......	......	......	......	......	......	......	13.36	14.90	15.50	15.38
19	......	......	......	......	......	......	......	......	13.30	13.90	15.50	15.50
20	......	......	......	......	......	......	......	......	13.45	14.90	15.45	15.50
21	......	......	......	......	......	......	......	......	13.27	14.90	15.50	15.65
22	......	......	......	......	......	......	......	......	14.08	14.90	15.50	15.70
23	......	......	......	......	......	......	......	......	14.10	14.90	15.45	15.80
24	......	......	......	......	......	......	......	......	14.18	14.95	15.40	15.80
25	......	......	......	......	......	......	......	......	14.24	14.85	15.40	15.80
26	......	......	......	......	......	......	......	......	14.05	14.92	15.47	15.80
27	......	......	......	......	......	......	......	......	14.10	15.05	15.53	15.83
28	......	......	......	......	......	......	......	......	14.10	15.12	15.42	15.80
29	......	......	......	......	......	......	......	......	14.15	15.25	15.40	15.80
30	......	......	......	......	......	......	......	......	14.25	15.02	15.40	15.80
31	......	......	......	......	......	......	......	......	......	14.85	......	15.77
Mean	......	......	......	......	......	......	......	......	13.88	14.83	15.46	15.54

Readings of the lower gauge at Kampsville Lock, 1893.

[Plane of reference, low water of 1879.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
1	2.25	1.82	12.15	14.45	19.18	17.68	7.22	1.18	—0.30	0.50	0.25	0.60
2	2.20	1.90	12.20	14.20	19.73	17.42	6.95	1.08	—0.35	0.60	0.35	0.40
3	2.18	1.90	12.15	13.98	20.07	17.27	6.68	1.00	—0.30	0.60	0.45	0.47
4	2.10	1.90	12.10	13.80	20.17	17.10	6.37	0.95	—0.23	0.60	0.50	0.65
5	2.10	1.90	12.10	13.58	20.13	16.82	6.07	0.92	0.02	0.60	0.55	0.70
6	2.05	2.22	12.15	13.35	19.98	16.45	5.78	0.85	* —0.58	0.60	0.55	0.70
7	2.00	3.05	12.22	13.10	19.67	16.00	5.60	0.80	† —1.72	0.55	0.55	0.65
8	1.95	3.38	12.65	12.90	19.50	15.55	5.57	0.77	† 0.48	0.60	0.55	0.55
9	1.90	3.52	13.25	12.73	19.25	15.18	6.43	0.67	† 0.65	0.60	0.55	0.55
10	1.90	3.55	13.77	12.60	18.97	14.75	6.25	0.70	0.65	0.60	0.55	0.55
11	1.85	3.50	14.30	12.55	18.70	14.35	5.55	0.67	0.65	0.60	0.55	0.55
12	1.85	3.55	14.75	12.83	18.53	13.95	5.00	0.62	0.45	0.60	0.55	0.65
13	1.80	4.00	15.20	12.90	18.35	13.58	4.02	0.60	0.35	0.60	0.55	0.80
14	1.80	5.50	15.65	12.95	18.15	13.20	4.27	0.57	0.35	0.60	0.55	0.85
15	1.80	7.95	16.15	12.95	17.95	12.90	3.90	0.53	0.15	0.60	0.55	0.85
16	1.75	9.85	16.62	12.78	17.75	12.68	3.68	0.50	0.08	0.60	0.55	0.90
17	1.75	10.83	16.90	12.52	17.55	12.33	3.45	0.43	0.35	0.60	0.55	0.95
18	1.75	10.90	17.10	12.40	17.35	12.00	3.25	0.40	0.35	0.60	0.55	0.63
19	1.75	10.87	17.22	12.40	17.15	11.55	3.10	0.32	0.35	0.60	0.55	0.95
20	1.75	11.13	17.30	13.02	16.98	11.15	2.85	0.23	0.35	0.60	0.55	1.15
21	1.75	11.20	17.30	13.45	16.83	10.75	2.65	0.20	0.25	0.60	0.55	1.05
22	1.80	11.35	17.30	13.85	16.60	10.37	2.45	0.15	‡ —1.58	0.60	0.55	1.50
23	1.80	11.45	17.25	14.20	16.30	10.08	2.25	0.15	0.35	0.60	0.55	1.75
24	1.80	11.72	17.02	14.47	16.03	9.87	2.13	0.05	0.43	0.60	0.50	1.70
25	1.80	12.00	16.80	14.87	15.75	9.75	1.98	—0.05	0.47	0.60	0.45	1.65
26	1.80	13.03	16.52	15.38	16.23	9.72	1.95	—0.05	0.30	‡ 0.33	0.50	1.65
27	1.80	12.53	16.05	16.02	16.80	9.33	2.05	—0.05	0.35	0.25	0.65	1.65
28	1.80	12.12	15.65	16.78	17.48	8.67	1.85	—0.08	0.35	0.25	0.52	1.65
29	1.80	......	15.25	17.57	17.95	8.13	1.65	—0.32	0.40	0.25	0.52	1.65
30	1.80	......	14.93	18.45	18.05	7.65	1.45	—0.65	0.50	0.25	0.60	1.65
31	1.80	......	14.70	......	17.90	......	1.28	—0.30	......	0.25	......	1.65
Mean	1.88	7.09	14.99	13.90	18.10	12.87	4.01	0.41	0.12	0.53	0.52	1.02

* Dam closed. † Valves open. ‡ Valves closed.

COMMERCIAL STATISTICS.

The following figures are taken from the annual report of the Merchants' Exchange, St. Louis, Mo., for the calendar year 1893:

Arrivals and departures of steamboats and barges at St. Louis, Mo., via Illinois River.

Month.	Arrivals.	Departures.	Month.	Arrivals.	Departures.
March	14	14	September	6	7
April	21	20	October	8	8
May	13	13	November	5	3
June	15	15			
July	13	11	Total	99	95
August	4	4			

Receipts and shipments, in tons, via Illinois River, at St. Louis, Mo.

Month.	Receipts.	Shipments.	Month.	Receipts.	Shipments.
March	9,580	560	September	1,280	45
April	24,530	810	October	1,520	260
May	5,270	1,265	November	720	242
June	5,180	1,120			
July	1,965	1,065	Total	50,605	5,785
August	560	415			

K K 5.

OPERATING AND CARE OF THE LA GRANGE AND KAMPSVILLE LOCKS AND DAMS, ILLINOIS RIVER, ILLINOIS.

The lock and dam at La Grange were operated and cared for during the fiscal year. The lock and dam at Kampsville were completed September 30, 1893, and have since been operated and maintained.

The expenses of operating and care have been paid from the general indefinite appropriation for "Operating and care of canals and other works of navigation, indefinite," contained in the river and harbor act of July 5, 1884, section 4.

On September 27, 1893, the head-bay platform of the La Grange Lock gave way. The timbers were insufficiently supported by stanchions, and had become softened by long immersion in foul water.

The lock was cofferdammed and pumped out, the broken timbers replaced, and 58 posts 12 inches square in cross section placed for supporting the valve platform. This work was costly because it happened that no dredge, pile-driver, or other appliance for doing the work was above the dam, and the lock could not be used. This required the necessary floating plant to be lifted over the dam, which was done.

Five hundred cubic yards of stone was placed below the La Grange dam to protect the bottom of the river below the apron against scour.

The approaches to both locks were kept dredged.

At Kampsville Lock a broken stone drain was built in rear of the land wall its entire length to take care of the surface drainage water; 17 snubbing posts were set, and the coping stones of the pier heads, and the step stones doweled with pins 1¼ inches diameter, 4 feet long, set in Portland cement. The number of craft passing La Grange Lock increased from 467 in 1893 to 509 in 1894. The tonnage, however, was less. Navigation was closed for three months on account of the accident at the La Grange Lock and because of the delay due the construction of the Kampsville Dam.

Money statement.

LA GRANGE LOCK.

Outstanding June 30, 1893	$1,021.61	
Allotment for fiscal year 1894	10,000.00	
		$11,021.61
June 30, 1894, amount expended during fiscal year		10,234.64
July 1, 1894, balance unexpended		786.97
July 1, 1894, outstanding liabilities		403.52
July 1, 1894, balance available		383.45

KAMPSVILLE LOCK.

Allotment for fiscal year June 30, 1894	7,580.00
June 30, 1894, amount expended during fiscal year	4,266.09
July 1, 1894, balance unexpended	3,313.91
July 1, 1894, outstanding liabilities	591.07
July 1, 1894, balance available	2,722.84

Expended during the fiscal year ending June 30, 1894, from the indefinite appropriation for "operating and care of canals and other works of navigation, indefinite," in operating and keeping in repair the La Grange Lock on the Illinois River.

Services of overseer and lock tenders	$4,069.10	
Fuel for boats and dredges	497.78	
Seed for lock grounds	3.75	
Lime and brushes for whitewashing buildings	9.45	
Hawser pipes for dredges	67.50	
Oil for lighting locks	10.96	
Paint and waste for repairs of plant	81.48	
Lumber for repairs to ice house	5.51	
Telephone service	31.25	
Gas for office	2.88	
Telegrams	2.85	
Total for operating and care		$4,782.51

COST OF REPAIRING BREAK IN HEADBAY FLOOR.

Services of assistant engineer and labor	$2,970.59	
Subsistence stores	616.48	
Lumber and piles	479.34	
Rubblestone	709.38	
Cement	167.40	
Sand	69.30	
Iron and steel	61.75	
Rope	69.89	
Hardware and tools	22.13	
Use of engine, pumping, and lock pit	49.00	
Kitchen outfit	136.26	
Rubber boots	29.25	
Mileage of officers	44.56	
Travel of assistant engineer	5.90	
Stationery	1.17	
Telegrams and express	18.93	
		5,452.13
Total		10,234.64

KAMPSVILLE LOCK, ILLINOIS RIVER.

Services of overseer, lock tenders, watchmen, etc	$3,478.05	
Fuel for boats and dredges	584.00	
Oil for lighting locks	22.36	
Cement and iron for coping of locks	34.58	
Snubbing posts	87.50	
Lanterns for watchmen's use	3.25	
Paint for plant	56.35	
Total		4,266.09
Grand total		14,500.73

REPORT OF MR. C. V. BRAINARD, ASSISTANT ENGINEER.

KAMPSVILLE, ILL., *June 30, 1894.*

CAPTAIN: I have the honor to submit the report of operating and care of locks and dams, Illinois River, for the fiscal year ending June 30, 1894.

LA GRANGE LOCK.

The work at this lock has consisted of rebuilding the icebreaker taken away by the ice in February, 1893, and building two houses 16 by 24 feet one story high for quarters, a wood and storehouse 16 by 30 feet for superintendent, and an ice house 16 by 16 by 16 feet. Two snubbing posts were set on the land wall, buildings and fences whitewashed, the grounds sown with blue-grass seed and kept free from drift and trash, and 100 tons of ice put up. Three thousand cubic yards of earth filling was put about the lock house. The levee on the west bank, extending from the head of the lock wall upstream, was repaired by filling in the breaks and raising it to grade.

On September 27 word was received that the head-bay floor of this lock had given way, a hole 10 by 12 feet being made. The work on the Kampsville Dam being practically complete the force and plant were transferred to this place. Trouble was experienced in having no plant above the dam. One flat with a pile-driver and one empty flat was pulled over the dam, the two ends of the lock cofferdammed and the lock pumped out. This lock had given trouble ever since opening by a settlement of the headbay, necessitating larger pinions yearly on the valve gearing. The cause was found to be a gradual bending of the timbers of the floor. Two of these cross timbers were found broken. These timbers were replaced by new ones. As originally built there was but one support between the ends of a 40-foot span. The platform was strengthened by putting two additional rows of posts across the lock under the timbers. These posts were of 12 by 12 inch pine resting on 12 by 12 inch footing pieces long enough to rest on 4 of the foundation sills. Fifty-eight of these posts and footings were put in. Four hundred feet of 12-inch drain tile was laid from the slough back of the United States grounds to the river.

KAMPSVILLE LOCK.

The first boat passed through this lock August 29, 1893. A broken rock drain was built along the land wall its entire length to take care of the surface and drainage water. Thirty-five dowel pins of 1¼-inch iron 4 feet long were used to fasten the step stones and coping about the pierheads.

Seventeen snubbing posts were set. Wooden fenders were put on both sides of the gates to protect them from passing boats. The lower entrance was finished to a least depth of 5 feet and a width of 120 feet. There is herewith a statement of tonnage passing La Grange Lock and also one of tonnage passing Kampsville Lock not reported at La Grange, and a list of boats navigating this river:

Tonnage passing La Grange Lock.

	Year ending June 30—				
	1890.*	1891.	1892.	1893.	1894.†
Steamboats........number..	142	280	265	291	296
Barges........do....	68	147	168	176	213
Tonnage, steamers........tons..	41,915	63,967	68,236	80,131	59,730
Tonnage, barges........do....	12,386	45,711	79,211	102,118	91,361
Ice........do....	(‡)	20,575	39,400	46,600	31,900
Wheat........bushels..	5,082	9,800	14,536	12,700	6,750
Corn........do....	....	18,176	33,800	29,691	45,900
Coal........tons..	100	650	729	225	1,087
Logs........feet, B M..	....	45,000	....	181,000	200,000
General merchandise........tons..	(‡)	(‡)	1,651	4,675	3,734
Passengers........number..	(‡)	(‡)	1,334	2,382	2,179
Stock........head..	(‡)	(‡)	219	298	2,307
Wood........cords..	....	70	250	....	60
Stone........cubic yards..	400	350	655	750	....
Lumber........M feet, B. M..	....	....	20,000	10,000	15,000
Brick........number..	....	....	40,000	....	....

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* Opened to navigation October 21, 1889.

† August, September, and October, 1894, river closed at Kampsville Dam and for repairs at La Grange Lock.

‡ No record kept.

Tonnage passing Kampsville Lock and not reported at La Grange.

Steamboats	number..	21
Barges	do....	15
Tonnage, steamers	tons..	3,148
Tonnage, barges	do....	1,500
Wheat	bushels..	63,850
Corn	do....	86,267
General merchandise	tons..	800
Passengers	number..	1,197
Wood	cords..	500
Stock	head..	3,760

While some of the items through La Grange Lock show a decrease from the year before, a comparison of 1894 made with the same months for 1893 shows a decided increase.

List of boats navigating the Illinois River.

Name.	Tonnage.	Name.	Tonnage.
Polar Wave	150	Imperial	96
Belle of Ottawa	10	Spread Eagle	529
Charlotte Boeckeler	143	Ferd Herold	544
City of Pekin	5	C. O	19
D. H. Schmoldt	15	City of Peoria	128
H. W. Longfellow	77	Gadabout	21
Lily (United States)	300	G. M. Sivley	98
D. H. Pike	465	Frankie Folsom	36
Jack Frost	350	Iowa	73
Joliet	76	Flora	14
Peoria	5	Alda	73
Lotus	22	Ariel	9
City of Brunswick	77	Mollie L	22
Cherokee	631	Chicago	6

Very respectfully, your obedient servant,

C. V. Brainard,
Assistant Engineer.

Capt. W. L. Marshall,
Corps of Engineers, U. S. A.

K K 6.

ILLINOIS AND MISSISSIPPI CANAL, ILLINOIS.

The object of this improvement is to furnish a navigable waterway from Lake Michigan to the Mississippi River at the mouth of Rock River in connection with the Upper Illinois River, and the proposed enlarged waterway along the present line of the Illinois and Michigan Canal.

The river and harbor act of September 19, 1890, contained the first appropriation for beginning the construction of this canal.

With reference to this work it is to be said that various surveys of different routes from the great bend of the Illinois River to the Mississippi River at or above the mouth of Rock River have been made—in 1871, G. P. Low (Report Chief of Engineers, 1871, p. 303); in 1882, Major Benyaurd (Report Chief of Engineers, 1883, p. 1757), and in 1885, Major Handbury (Report Chief of Engineers, 1886, p. 1707).

There was also a report upon this canal by a Board of Engineers in 1887 under the provisions of the river and harbor act of August, 1886 (Report Chief of Engineers, 1887, p. 2125). All of the local engineers and the Board of Engineers of 1887, for engineering reasons, have preferred and recommended the Marais d'Osier route, but for commercial reasons the Chiefs of Engineers, Gens. Newton and Duane, and the Secretaries of War preferred the Rock Island route, and that route has been finally adopted.

Detailed plans and estimates based entirely upon preliminary surveys, and under the act of August 11, 1888, were prepared and submitted to Congress June 21, 1890, the report of which location, plans, and estimates were submitted June 21, 1890, and published (without maps and drawings) as House Ex. Doc. No. 316, Fifty-first Congress, first session.

This report was the basis evidently of subsequent appropriations.

The plans submitted, as subsequently modified, contemplate the construction of a canal 80 feet wide at the water surface, 7 feet deep, with locks 170 feet long, 35 feet wide, extending from a point at the great bend of the Illinois River, near the town of Hennepin, via the valleys of Bureau, Pond, and Cowcatcher Creek, to the summit level at the twentieth mile, ascending 205 feet through 24 locks with lifts varying from 3 feet to 10 feet each; thence to the feeder junction at the twenty-fifth mile; thence to Rock River, at Penney Slough, at the fiftieth mile; thence down Rock River 27 miles to its mouth. The descent from the summit level to the mouth of Rock River, at low water in the Mississippi River, is 102 feet, made by 13 locks and one guard lock of from 5 to 12 feet lifts. The length of the western slope from the feeder junction to the Mississippi River is 52 miles, and of the main trunk of the canal 77 miles, of which 50 miles is canal and 27 miles slack water in Rock River, by means of locks and dams.

The proposed feeder is of the same dimensions as the canal, and is 34¾ miles in length.

This location is subject to modification, the termini remaining the same.

Under the requirements of the act of September 19, 1890, and with the approval of the Secretary of War (see Annual Report Chief of Engineers, 1892, p. 2297, *et seq.*), the work of constructing the canal began July, 1892, at the mouth of Rock River, upon the construction of a canal, approximately 4½ miles in length, around the lower rapids of Rock River, terminating at the principal mouth of Rock River.

The works of construction required along this section consist in two dams across the arms of Rock River, at the head of the rapids; 4½ miles of canal trunk, of which 4,000 feet, more or less, is formed by embankments in the bed of Rock River; 1 guard lock and 2 lift locks, 7 sluices, 1 culvert, 2 metal bridges, and 1 pontoon farm bridge.

WORK UNDER CONTRACT.

Western section.—At the close of the last fiscal year a contract was in force with John D. Lynch, Monmouth, Ill., for the earthwork necessary for the construction of 3 miles or less of the canal trunk and for the necessary sand and pebbles at the guard lock and Lock 36. This contract was completed during the year, except that the sand and pebbles were not furnished in full, as they were not found in the canal excavation. One hundred and sixty-four thousand two hundred and forty-eight cubic yards of earthwork under this contract were paid for during the fiscal year.

The sand and pebbles were purchased in the open market, and were taken from deposits in the immediate vicinity of the canal.

WORK BY HIRED LABOR.

The work carried on by hired labor during the past year has been gratifying in results, and is detailed at length in the accompanying report of Assistant L. L. Wheeler, who has been in local charge of the western section since the inception of the work.

The work by hired labor has consisted in:

(1) The completion of the foundation of Lock 37, 12 feet lift (contract of A. J. Whitney, nullified June 10, 1893), and of the masonry (concrete) of that work, and the framing of the gates thereof.

(2) The completion of the masonry of Lock 36, of 6 feet lift, and of the masonry of the pontoon bridge piers above it, and the framing and hanging of the gates.

(3) The preparation of the foundation and construction of the masonry and gates of four 21 feet wide sluiceways at the mouth of Mill Creek.

(4) The construction of the masonry of the guard lock, and framing and placing the gates.

(5) The construction of the masonry for three 21-foot sluiceways, one abutment of dam, one 10-foot arch culvert, and the retaining walls at the guard lock, 420 linear feet in length.

(6) The construction of an earth cofferdam across the north arm of Rock River, and the construction of 450 linear feet of the base of the dam across this chute.

(7) The construction of three-fourths of the embankments in Rock River over 4,000 feet in length and the riprapping with stone of these embankments.

(8) The excavation of earth and rock of the canal trunk above the mouth of Mill Creek throughout four-fifths of its extent, and in the crushing of stone and accumulation of material and tools for all the masonry work on this section of the canal, the lock gates and dams.

All of the material for the completion of the work has been contracted for, or ordered, except for the revetments at Locks 36 and 37, and it is confidently expected that this section of the canal will be open for navigation before the close of the present working season.

On this work the principal matter of interest is the artificial stonework of Portland cement concrete. The work on this canal marks the beginning in America of constructions of concrete without stone facing, applied to canal locks. The locks and all masonry, including bridge piers and abutments, sluiceway piers, and abutments of dams, have been or are to be constructed entirely of artificial stone of Portland cement, mixed with crushed stone and gravel found in the immediate vicinity of the work and in great part excavated from the prism of the canal. The hollow quoins of the locks are of cast iron built into and anchored to the concrete as the work progresses. With this exception, there is no facing to the artificial stone or concrete, which has been constructed with great care, and it is important that the manipulation of this material as well as the ingredients should be carefully given as part of the record of this experiment.

The methods applied in depositing the material were in the main developed by the officer in charge since 1889 while serving as consulting engineer for the commissioners of Lincoln Park, and were directed as a guiding motive to the securing of masses of concrete without planes and surfaces of weakness at undesirable places, along which cracks and failures might take place. It is a common practice in making large masses of concrete to deposit and consolidate it in layers of such extent that each layer has time to partially harden or set before another layer is deposited thereon. At nightfall work is commonly suspended until the next day, when work is resumed after cleaning the surface.

The layers are seldom carefully leveled and the resulting mass intended to be monolithic is traversed by numerous approximately horizontal surfaces of weakness along which cracks will inevitably occur after exposure to weather in rigorous climates. Surfaces and joints of weakness are also frequently due to the practice of using whole barrels of cement for each batch, resulting in a weak stratum whenever a barrel of defective, unsound, or weak cement is encountered. The custom also of "finishing" or plastering surfaces after the forms are removed results in planes of weakness; also the practice of using dissimilar cements in facing and backing. All these common practices are pernicious and it is due to the results obtained from them that the material has not been more favored for important masonry constructions where stone is expensive.

In constructing the masonry on this work the following rules have been adopted and adhered to since the inception of the work:

I. The forms or molds of the walls will be divided by vertical partitions perpendicular to the longest axis of the mass, and the walls be constructed by filling alternate sections.

II. The sections will be filled in horizontal layers, well rammed, each layer to be deposited before the "initial set" of the previously deposited layer. When the work of filling a section is begun, it must proceed without intermission to completion, working night and day if necessary.

III. The facing and backing must go on simultaneously in same horizontal layers, using the same cement in the facing as in the backing with no defined lines of demarcation between the facing which contains no stone and the concrete backing.

IV. When the top surface of the coping is reached it will be finished after ramming by cutting off the excess by a straight edge, and rubbed smooth and hard with a float. No plastering or wet finishing coat will be allowed.

V. The facing of the walls will not be finished by plastering or washing with cement after the forms are removed, nor dressed in any manner beyond chiseling away rough ridges should the plank forming not be smooth.

VI. The concrete shall be mixed with all the water it will take without water showing after ramming, or without "quaking" upon ramming.

VII. At such intervals as may be necessary vertical wells at least 1 foot square will be formed along the middle of the masses of concrete reaching to near the bottom thereof. The masses of concrete after forming will be kept sheltered from the sun, the outer surfaces kept moist and the wells kept filled with water until well set (about three weeks). The wells will then be filled with concrete.

VIII. In preparing the cement for mixing with other ingredients of concrete from 5 to 10 barrels will be kept thoroughly mixed dry, to guard against chance barrels of defective cement, and the necessary quantity of cement will be taken for each batch from this mixture.

IX. Two cements of different qualities shall not be used in the same section, but as far as practicable each mass shall be homogeneous throughout, but a slight excess of cement is allowable in the facing to reduce its capacity to absorb water.

The cements used for the masonry have been three brands of fine ground German Portlands, but nearly all of it has been made from Alsen's Portland cement (yellow label). Ninety-nine per cent of this cement passes a sieve 2,500 meshes to a square inch, 87 per cent passes 10,000 meshes to the square inch; its initial set, determined by one-fourth pound weight on a wire one-twelfth inch in diameter, occurs in from twenty-two to thirty minutes, and it sets hard in about two hours. The rate at which cement was deposited was about 1 cubic yard in five minutes. This rate was not up to the capacity of the mixer, but was determined by the rate at which the ramming into the molds could be done and the molds prepared.

There is no reason, therefore, why the concrete may not be deposited continuously, each layer before the preceding layer has reached its "initial set." To accomplish it, however, requires for this particular cement that the sections shall be of such size that each horizontal layer shall not contain more than four batches of concrete, requiring twenty minutes for its deposit; the succeeding batches to be deposited in the same order in each layer.

In constructing the concrete masonry large stones have not, as a rule, been incorporated in the masses, but the walls have been made as nearly homogeneous in texture as practicable, consistent with the necessary facing along the exposed parts of the masonry. Continuity in depositing and homogeneity in structure are essential elements of success in concrete construction of thin or moderately thick walls, and every effort has been made to attain them.

Up to the close of the fiscal year, 10,130 cubic yards of concrete masonry were constructed, at an average cost of $8.77 per cubic yard. There remains to be built to complete the masonry of this section of the canal the piers and abutments of two bridges.

The estimate for the canal around the lower rapids of Rock River, exclusive of the cost of surveys and expenses of right of way, was $472,000, and although the work has been very materially increased in volume over that contemplated in the estimates, mainly by constructing sluiceways, culvert, riprapping the banks, and widening the canal through the rock section, to obtain stone for riprap, and for the structures along the line, it is confidently expected to complete the work within the estimate. This attainment will be due to the substitution of concrete for natural stone in the masonry, and to the unusually favorable location of this section of the canal.

The substitution of concrete for cut stone has also allowed the canal locks to be increased in size without increase of cost.

In the construction of locks on soft foundations it is the common teaching of the text-books that the bottoms of the locks or foundations shall be of sufficient strength on pumping out the lock to resist an upward pressure due to a head of water equal to the vertical distance from the bottom of the foundation to the surface of the upper level. This rule necessitates such thick foundations of concrete that it has not been generally adopted by the U. S. engineers in their practice, but still, in some cases unnecessarily heavy foundations and floors have been laid to resist such hydrostatic pressure.

On this canal the foundations have been designed with close-fitted sheet piling at head and tail bays to prevent underleakage, and the foundation made strong enough to sustain the lock walls and the chamber full of water, but instead of providing against an accumulation of a possible hydrostatic head of water below the foundation tending to push it up, provision is made for subdraining to the lower level just above the probable position of any cofferdam of all accumulations of water under the foundations, or in rear of the lock walls, while at the same time prohibiting as far as practicable communication between drains and lock chambers. Whenever a lock is pumped out the water is also removed from behind the walls and to the level of the foundation. This is simply an application of the principle of "weep" holes, a common resort in building retaining walls to get rid of fluid pressure, but the principle is not inculcated in text books for foundations of canal locks nor mentioned in treatises and descriptions of special structures; it is therefore mentioned here as a matter that may be useful in similar situations. It is always better to avoid than to fight useless and dangerous forces, or, better, give them a free right of way around our works than attempt to prevent their working.

Eastern section.—The necessary field work has been done for locating the canal from the Illinois River to the feeder junction, and surveys, plats, and descriptions of lands required for right of way have been made. Eight miles of the right of way have been acquired by condemnation. Plats, maps, descriptions, and abstracts of title for the next 8 miles of the desired right of way have been placed in the hands of the Department of Justice for acquiring title, and the same prepared ready to submit for the remaining 8 miles of the line as far as to the feeder junction.

A survey has been completed from the feeder junction to Rock River, at the mouth of Green River, and estimates of cost of this line made. The line has not been adopted as yet, as it is believed that further surveys will develop a better location than yet surveyed. The line from the feeder junction to Penneys Slough is not a favorable one for construction, as much of the route is over swampy ground remote from means of transportation. The crossing of Green River is difficult or impracticable, and the route demands locks and dams in Rock River, which is bordered by a rich valley, much of which will be overflowed by any dams that will be effective in establishing navigation. In the judgment of the officer in charge, Rock River should not be dammed by any additional dams above the head of the lower rapids, and it will evidently facilitate the construction of the work to locate the canal near solid roads over which material may readily be transported and its usefulness increased by locating it where the population is most dense rather than through the swamps of St. Peters Marsh.

The earthwork of the first 8 miles of the eastern section of the canal will be advertised immediately and the rest of the section put under execution as rapidly as money is appropriated and the right of way secured.

There are attached hereto detailed reports of Assistants Wheeler and Long, which give full information relating to the parts of the work assigned to them.

The work so far has been delayed by the necessary formalities involved in the acquisition of the right of way, but it now seems that the eastern section, 25 miles in length, including 24 of the locks out of 38 and 3 out of 5 of the aqueducts, will soon be acquired, when the appropriations may well be increased and the work more rapidly executed.

Money statement.

July 1, 1893, balance unexpended		$810,183.61
June 30, 1894, amount expended during fiscal year	$269,266.50	
August, 1893. refunded Capt. Marshall, account erroneous deposit 1892	.50	
		269,267.00
July 1, 1894, balance unexpended		540,916.61
July 1, 1894, outstanding liabilities	28,062.26	
July 1, 1894, amount covered by uncompleted contracts	11,200.00	
		39,262.26
July 1, 1894, balance available		501,654.35

Amount (estimated) required for completion of existing project	5,925,960.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	1,000,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

ANNUAL STATEMENTS AND TOTAL COST STATEMENTS.

WESTERN SECTION.

Fiscal year 1891.

Surveys	$9,305.95	Surveys proper	$9,305.95
Superintendence and office	1,392.86	Superintendence and office closed into surveys	1,392.86
Contingencies	236.27	Contingencies closed into surveys	236.27
Property	356.34	Care and repair of property closed into surveys	29.94
Care and repair of property	29 94	Part of property closed into surveys	142.70
Right of way	434.00		11,107.72
		Right of way	434.00
		Value of property at close of fiscal year	213.64
Total	11,755.36	Total	11,755.36

Fiscal year 1892.

Surveys	$9,551.99	Surveys proper	$9,551.99
Superintendence and office	1,472.19	Superintendence and office closed into surveys	1,472.19
Contingencies	246.66	Contingencies closed into surveys	246.66
Property	11.76	Care and repair of property closed into surveys	57.10
Care and repair of property	57.10	Property closed into surveys	3.66
Right of way	13,710.14		11,331.60
Canal trunk, first mile	7.47	Right of way	13,710.14
Canal trunk, second mile	7.47	Canal trunk, first mile	7.47
Canal trunk, third mile	140.08	Canal trunk, second mile	7.47
Lock No. 37	7.48	Canal trunk, third mile	140.08
Lock No. 36	7.47	Lock No. 37	7.48
Guard lock	15.30	Lock No. 36	7.47
		Guard lock	15.30
		Value of property purchased during fiscal year at close of year	8.10
Total	25,235.11	Total, fiscal year 1892	25,235.11

Total cost to close of fiscal year 1892.

Surveys, fiscal year 1891	$11,107.72	
Surveys, fiscal year 1892	11,331.60	
Deterioration of property purchased in 1891	55.22	
		$22,494.54
Right of way, fiscal year 1891	434.00	
Right of way, fiscal year 1892	14,710.14	
		14,144.14
Canal trunk, first mile		7.47
Canal trunk, second mile		7.47
Canal trunk, third mile		140.08
Lock No. 37		7.48
Lock No. 36		7.47
Guard lock		15.30
Value of all property on hand at close of fiscal year 1892		166.52
Total expenditure to date		36,990.47

Fiscal year 1893.

Surveys	$444.38
Right of way	12,662.50
Canal trunk, first mile	9,517.15
Canal trunk, second mile	5,012.58
Canal trunk, third mile	5,106.57
Canal trunk, fourth and fifth miles	18,196.22
Lock No. 37	10,702.98
Lock No. 36	11,403.29
Guard lock	22,210.25
Dam abutments	8,699.14
Bridges	125.00
Superintendence and offices	10,952.47
Contingencies	848.99
Property	28,917.29
Care and repair of property	498.51
Total for fiscal year 1893	145,327.32

Distribution of contingent expenses, fiscal year 1893.

	Works of construction.				Lock 37.	Lock 36.	Guard lock.	Abutments.
	First mile.	Second mile.	Third mile.	Fourth and fifth miles.				
Construction works	$9,517.15	$5,042.58	$5,106.57	$18,196.22	$10,702.98	$11,403.29	$22,210.25	$8,699.14
Superintendence and office	1,146.97	607.78	615.49	2,192.95	1,289.91	1,374.27	2,676.71	1,048.39
Contingencies	88.91	47.11	47.71	169.99	99.99	106.53	207.48	81.27
Care and repair of property	52.20	27.67	28.02	99.81	58.71	62.55	121.83	47.72
One-fifth cost of property				3,855.64			1,927.82	
Totals for construction works	10,805.23	5,725.14	5,797.79	24,514.61	12,151.59	12,946.64	27,144.09	9,876.52

Total cost to close of fiscal year 1895.

	At close of 1892.	Fiscal year 1893.	Deterioration of property purchased in 1891-'92.	Total.
Surveys	$22,494.54	$444.38		$22,938.92
Right of way	14,144.14	12,662.50		26,806.64
Canal trunk, first mile	7.47	10,805.23		10,812.70
Canal trunk, second mile	7.47	5,725.14		5,732.61
Canal trunk, third mile	140.08	5,797.79		5,937.87
Canal trunk, fourth and fifth miles		24,514.61	$37.00	24,551.61
Lock No. 37	7.48	12,151.59		12,159.07
Lock No. 36	7.47	12,946.64		12,954.11
Guard lock	15.30	27,144.09	18.50	27,177.89
Dam abutments		9,876.52		9,876.52
Bridges		125.00		125.00
Property (value of)	166.52	23,133.83		23,244.85
Total	36,990.47	145,327.32	55.50	182,517.79

Fiscal year 1894.

Right of way	$44.50
Canal trunk, first mile	5,464.00
Canal trunk, second mile	10,054 94
Canal trunk, third mile	7,915.43
Canal trunk, fourth and fifth miles	68,636.50
Lock No. 37	54,793.27
Lock No. 36	15,598.60
Guard lock	30,771.59
Dams	3,501.00
Bridges	1,093.67
Superintendence and office	14,872.12
Contingencies	624.41
Property	16,011.33
Care and repair of property	514.22
Total for fiscal year 1894	229,895.58

Distribution of contingent expenses, fiscal year 1894.

WORKS OF CONSTRUCTION.

	First mile.	Second mile.	Third mile.	Fourth and fifth miles.	Lock 37.
Construction works	$5,464.00	$10,054.94	$7,915.43	$68,636.50	$54,793.27
Superintendence and office	410.76	755.99	595.05	5,159.83	4,119.15
Contingencies	17.25	31.74	24.98	216.64	172.95
Care and repair of property	14.20	26.14	20.58	178.41	142.42
One-fifth cost of property	88.94	163.67	128.84	1,117.20	891.87
Total	5,995.15	11,032,48	8,684.88	75,308.58	60,119.63

Distribution of contingent expenses, fiscal year 1894—Continued.

WORKS OF CONSTRUCTION—Continued.

	Lock 36.	Guard lock.	Dams.	Bridges.	Total.
Construction works	$15,598.00	$30,771.59	$3,501.00	$1,093.67	$197,829.00
Superintendence and office	1,172.64	2,313.29	263.19	82.22	14,872.12
Contingencies	49.23	97.12	11.05	3.45	624.41
Care and repair of property	40.54	79.99	9.10	2.84	514.22
One-fifth cost of property	253.90	500.87	56.98	....	3,202.27
Total	17,114.91	33,762.86	3,841.32	1,182.18	217,042.02
Value of property purchased during fiscal year 1894 at close of year (four-fifths cost)	....	....	....	....	12,809.06
Right of way	....	....	....	....	44.50
					229,895.58

Total cost to close of fiscal year 1894.

	At close of 1893.	Fiscal year 1894.	Deterioration of property purchased previous to 1894.	Total.
Surveys	$22,938.92	....	....	$22,938.92
Right of way	26,806.64	$44.50	....	26,851.14
Canal trunk, first mile	10,812.70	5,995.15	$129.11	16,936.96
Canal trunk, second mile	5,732.61	11,032.48	237.61	17,002.70
Canal trunk, third mile	5,937.87	8,684.88	187.05	14,809.80
Canal trunk, fourth and fifth miles*	24,551.61	75,308.58	1,621.92	101,482.11
Lock No. 37†	12,159.07	60,119.66	1,291.80	73,573.53
Lock No. 36	12,954.11	17,114.91	368.60	30,437.62
Guard lock ‡	27,177.89	33,762.86	727.15	61,667.90
Dam abutments	9,876.52	....	....	9,876.52
Dams	....	3,841.32	82.73	3,924.05
Bridges	125.00	1,182.18	....	1,307.18
Property (value of)	23,244.85	12,809.06	....	31,404.94
Total	182,317.79	229,895.58	4,648.97	412,213.37

*Includes four sluiceways and piers.

†Material in excess of requirements at Lock 37, of unknown value, was moved to Lock 36 and used in the construction of that lock, and the cost of Lock 37 should be reduced and the cost of Lock 36 increased thereby.

‡Includes also three sluiceways and one 10-foot arch culvert.

EASTERN SECTION.

Fiscal year 1893.

Surveys	$5,363.94	Surveys proper	$5,363.94
Superintendence and office	1,352.80	Superintendence and office closed into surveys	1,352.80
Property	1,228.73	Part of property closed into surveys	245.75
Right of way	340.00		
			6,962.58
		Right of way	340.00
		Value of property at close of fiscal year	982.98
Total	8,285.56	Total	8,285.56

Fiscal year 1894.

Surveys	$15,454.85	Surveys proper	$15,454.85
Superintendence and office	1,722.84	Superintendence and office closed into surveys	1,722.84
Contingencies	76.65	Contingencies closed into surveys	76.65
Property	128.44	Part of property closed into surveys	25.69
Right of way	21,988.14		
			17,280.03
		Right of way	21,988.14
		Value of property purchased during fiscal year	102.75
Total	39,370.92	Total	39,370.92

Total cost to close of fiscal year 1894.

	Fiscal year 1893.	Deterioration of property purchased in 1893.	Fiscal year 1894.	Total.
Surveys	$6,962.58	$196.90	$17,280.03	$24,439.21
Right of way	340.00		21,988.14	22,328.14
Property (value of)	982.98		102.75	889.13
Total	8,285.56	196.90	39,370.92	47,656.48

Total expenditures to end of fiscal year 1894.

Western section	$412,213.37
Eastern section	47,656.48
Total	459,869.85

Consolidated abstract of proposals for the design, manufacture, and erection of the superstructures of one single-track metal railroad swing bridge and one metal highway swing bridge across the Illinois and Mississippi Canal, near Milan, Ill., received in response to advertisement dated March 15, 1894, and opened at 12 m., central time, May 1, 1894, by Capt. W. L. Marshall, Corps of Engineers.

No.	Name and address of bidder.	Railroad.		
		Class of bridge.	Material.	Price.
1	Missouri Valley Bridge and Iron Works, Leavenworth, Kans.	Truss	Steel	$8,949.00
2	Chicago Bridge and Iron Works, Chicago, Ill	High truss	do	7,494.00
3	F. C. McMath, Detroit, Mich	Truss	do	8,621.00
4	Wisconsin Bridge and Iron Co., Milwaukee, Wis	do	do	7,830.00
5	Mount Vernon Bridge Co., Mount Vernon, Ohio	do	do	9,700.00
6	The American Bridge Works, Chicago, Ill	do	Steel and iron	7,825.00
7	Charles L. Strobel, Chicago, Ill	do	Steel	8,200.00
		Riveted truss	do	8,200.00
		Girder	do	8,650.00
8	Youngstown Bridge Co, Youngstown, Ohio	do	do	9,100.00
		Truss	do	8,300.00
9	Phœnix Bridge Co., Philadelphia, Pa	do	do	8,904.60
10	A. & P. Roberts Co., Philadelphia, Pa	do	do	11,275.00
11	The King Bridge Co., Cleveland, Ohio	do	Steel and iron	6,955.00
12	Toledo Bridge Co., Toledo, Ohio	do	Steel	7,888.00
13	New Jersey Steel and Iron Co., Trenton, N. J	do	do	10,083.00
14	Milwaukee Bridge and Iron Works, Milwaukee, Wis.	do	Steel and iron	8,700.00
15	Wrought Iron Bridge Co., Canton, Ohio			10,300.00

No.	Name and address of bidder.	Highway.			Total price for the two bridges.
		Class of bridge.	Material.	Price.	
1	Missouri Valley Bridge and Iron Works, Leavenworth, Kans.	Truss	Steel	$5,149	$14,098.00
2	Chicago Bridge and Iron Works, Chicago, Ill.	Low truss	do	3,994	11,488.00
3	F. C. McMath, Detroit, Mich	Tritruss	do	5,841	14,462.00
4	Wisconsin Bridge and Iron Co., Milwaukee, Wis.	Truss	do	4,970	12,800.00
5	Mount Vernon Bridge Co., Mount Vernon, Ohio.	do	do	5,450	15,150.00
6	The American Bridge Works, Chicago, Ill	do	Steel and iron	4,725	12,550.00
7	Charles L. Strobel, Chicago, Ill	do	Steel	5,100	13,300.00
8	Youngstown Bridge Co., Youngstown, Ohio	do	Steel and iron	4,335	12,635.00
9	Phœnix Bridge Co., Philadelphia, Pa	do	Steel	5,326	14,230.60
10	A. & P. Roberts Co., Philadelphia, Pa	Girder	do	6,760	18,035.00
11	The King Bridge Co., Cleveland, Ohio	Truss	Steel and iron	4,245	*11,200.00
12	Toledo Bridge Co., Toledo, Ohio	do	Steel	4,748	12,636.00
14	New Jersey Steel and Iron Co., Trenton, N. J.	do	Steel and iron	6,618	16,701.00
14	Milwaukee Bridge and Iron Works, Milwaukee, Wis.	do	do	4,800	13,500.00
15	Wrought Iron Bridge Co., Canton, Ohio			7,935	18,235.00

* Lowest bid for the two bridges taken together. Bid accepted.

I certify that above abstract is correct, and that there is available for this work $500,000.

W. L. MARSHALL,
Capt., Corps of Engineers.

Abstract of contracts for constructing Illinois and Mississippi Canal in force during the fiscal year ending June 30, 1893.

Name and address of contractor.	Nature of contract.	Date.	To expire—
John D. Lynch, Monmouth, Ill.	Earthwork 3 miles, canal trunk, sand, and pebbles at Lock 36, and guard lock.	Sept. 2, 1892	June 30, 1893*
The King Bridge Company, Cleveland, Ohio.	Building superstructures for two metal swing bridges across the Illinois and Mississippi Canal, near Milan, Ill.	May 21, 1894	Oct. 15, 1894

* Contract extended to November 15, 1893; completed September 30, 1893.

REPORT OF MR. L. L. WHEELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Milan, Ill., June 30, 1894.

CAPTAIN: I have the honor to submit the following report upon the work on the Illinois and Mississippi Canal, under my supervision, during the fiscal year ending June 30, 1894. A description of the work in progress here is given in my annual report dated June 30, 1893. (Report Chief of Engineers for 1893, p. 2838.)

CONSTRUCTION UNDER CONTRACT.

At the beginning of the year a contract was in force with John D. Lynch, of Monmouth, Ill, for the construction of 3 miles of canal trunk and for the delivery of sand and pebbles at guard lock and at Lock 36.

It was expected that the excavation of the canal trunk would furnish the required amount of pebbles, but not nearly as great a quantity was found as was expected, and under the terms of the contract he could not be compelled to furnish them from other sources.

High water prevented work on the canal trunk until in July and rendered an extension of contract necessary, but as soon as the water would permit a large force was put at work and the earthwork completed and accepted. The total amount of earthwork paid for during the year was 164,348 cubic yards, but a large proportion of the work had been done in the preceding year and not paid for.

CONSTRUCTION BY HIRED LABOR.

Concrete work.—During the year a 4-foot cubical concrete mixer was received, and with special hoisting apparatus has been in successful operation during the year. Both the hoist and mixer are run by one 15-horse-power portable engine, the mixer making 9 revolutions per minute and the hoist about 150.

Plate No. 5 shows a view of the mixing machinery as set up at Lock 36. The entire mixing apparatus was designed to suit all the conditions at the several sites of masonry construction. As shown in the view, the A frames extend 5 feet beneath the surface of the ground, but the entire height was required at the guard lock and at Lock 37. The whole apparatus is put together with bolts, and can readily be taken apart. The sand, pebbles, and broken stone were loaded into side-dump cars of the required dimensions, and, with the dry cement and water, dumped into a charging box holding about 45 cubic feet, sunk below the level of the ground. The charging box was then hoisted and carried by a traveler over a large hopper and dumped into the mixer. The angle of the truss is such, that the same cable hoists the box and carries it along the truss without the aid of any auxiliary apparatus. After being thoroughly mixed, the concrete was dumped into side-dump cars, and hauled by horses to the forms. Plate No. 4 shows the north wall of Lock 36 completed, the south wall building, and the general arrangement of forming. The forming consists essentially of a longitudinal sill in center of lock bolted to the foundation or anchored to the rock, transverse sills notched to receive braces, and 8 by 10 inch posts. The lateral sills abut against foot of posts. When posts were lined and plumb the braces were placed in notches, and 4 by 8 blocks lag-bolted on posts at upper end of braces. The form was then lined with 4 by 8 pine dressed to a uniform thickness. The back was lined with rough 2-inch plank and braced against the earth slope. The forming has been used at the three locks and at sluice gates, and proved to be well designed for the purpose. On account of the greater height of walls at Lock 37 it was necessary to splice the upright timbers and add a row of longer braces on each side.

A number of barrels of cement were broken and the cement thoroughly mixed, and from this the cement for a charging was taken. Usually from 5 to 10 barrels of cement were kept mixed together in the cement box. The water was measured in a small barrel, but the quantity used varied from time to time according to the weather and condition of ingredients, the quantity being regulated entirely by condition of concrete when rammed. It was intended to add the largest amount of water possible, and still not have the concrete quake when thoroughly rammed. In the walls of guard lock, Lock 37, some sections of Lock 36, and walls of Mill Creek sluice gates holes 12 inches square and extending to within a few feet of bottom of walls were left and kept filled with water for several weeks. The walls were also kept thoroughly wet on the outside for several weeks. The material for facing and coping was mixed entirely by hand, and the same precaution observed in regard to keeping the contents of several barrels mixed together.

In all the concrete work here the principle has been observed of dividing the masonry to be built into sections by vertical bulkheads and filling each section in thin layers with freshly mixed concrete without stopping work until the coping was finished. The time required to fill the sections varied from eight to twenty-four hours. The largest sections contained about 250 cubic yards. The total amount of concrete deposited at the three locks and at sluice gates is 10,130 cubic yards, costing $88,830.07, or at a cost of $8.77 per cubic yard. This does not include 1,073.5 cubic yards of Utica cement concrete in the foundation of Lock 37.

Guard lock.—The masonry at the guard lock consists of the lock walls proper, a culvert 150 feet long with interior dimensions of 10 feet by 6 feet 9 inches, two Taintor gate piers, a dam abutment, the three walls of which are 43, 50, and 30 feet long respectively, and two low retaining walls, the aggregate length of which is 420 feet.

At the beginning of the year 634 cubic yards of concrete had been mixed by shovels and deposited in forms by means of wheelbarrows. The work had been seriously delayed by the failure of the contractor to supply the screened pebbles, and also by the difficulty of obtaining suitable rock for crushing. As soon as suitable rock could be had the crusher was run sixteen hours daily, and the material was soon on hand for making more rapid progress. The mixing machinery was first set up at the guard lock, and some delays in its successful operation followed, mainly caused, however, by the inexperience of the men using it. In all 3,128 cubic yards of concrete were deposited during the year. The proportions used were 1 cement, 2½ sand, and 5 broken stone. When pebbles were used they replaced one of the parts of stone. All of the exposed surfaces of masonry was composed of 1 part cement and 2 parts sand. The facing was made 8 inches thick of this material and the coping 5 inches. A small amount of Utica cement was used as filling back of culvert walls and as foundation for retaining walls. The total amount of concrete deposited at the guard lock is 3,762 cubic yards, costing $32,122.24, or at a cost of $8.54 per cubic yard. One cubic yard of concrete required 1.40 barrels of cement.

Statement of cost of 3,762 cubic yards of concrete masonry at guard lock.

5,246 barrels Portland cement	$15, 603. 82
152 barrels Utica cement	83. 60
2,901 cubic yards crushed stone	1, 709. 15
1,970 cubic yards sand	1, 398. 41
128 cubic yards screened pebbles	113. 30
Lumber for forming	2, 635. 96
Miscellaneous bills	416. 72
Labor, building forms, trestles, etc	2, 726. 72
Labor, mixing and placing concrete	6, 693. 02
Labor, pumping, etc	741. 54
Total	32, 122. 24

Adjoining the lock is a sluiceway for letting water into the canal, which is closed by three Taintor gates, each 21 feet wide and 13 feet high. The upstream face is cylindrical, the radius of the circle being 12 feet 3 inches, with center 6 inches above center of horizontal trunnions, about which the gate revolves. The gates are hoisted by means of a hoisting carriage running on a track on a bridge extending over the gates.

During the winter the lumber and iron for the sluice gates and lock gates were received, the gates built and painted, ready for use, except placing maneuvering gear for operating the lock gates. The cost of the gates is as follows:

	Lock gates.	Sluice gates.
Lumber	$511. 64	$408. 60
Ironwork	807. 57	732. 45
Paints and miscellaneous bills	70. 18	105. 00
Labor, carpenters, hauling, etc	923. 52	774. 94
Painting	30. 35	45. 53
Labor, pumping, and miscellaneous	265. 12	265. 12
Total	2, 608. 38	2, 331. 64

The space back of the south wall has been graded in and the emankment on the north side of sluiceway built and riprapped on both sides. The earth and rock just west of the lock and sluiceway have been excavated and used partly for filling cribs, and partly as a cofferdam, inclosing an area in the river just east of the lock, where the rock rises from 1 to 2 feet above grade.

Crib approaches have been built both above and below the lock. Below the lock the cribs are continuous, 8 feet wide, 9 feet high, and have a combined length of 228 feet. Above the lock the crib on south side is also continuous, being 8 feet wide, 13 feet high, and 110 feet long. On the north side the cribs are detached and consist of three cribs 16 by 16 feet, and one crib 16 by 26 feet, all 11 feet high.

The cost of the crib work is as follows:

Lumber	$780.72
Iron, drift bolts, etc	36.26
Labor, carpenters, etc	366.04
Labor, filling with stone	592.50
Total	1,775.52

The entrance to the culvert has been excavated, and the sides partly slope paved.

Accompanying this report are two views (Pls. 6 and 7) showing the condition of the lock and related works at the end of the fiscal year.

Lock 36.—The contract for the foundation has been completed in the previous fiscal year. The contract for furnishing the sand and pebbles for masonry was in force, but the canal trunk did not furnish sufficient quantity of pebbles to fill the contract and other material had to be obtained. The crusher was kept at work late in the fall until 1,194 cubic yards of crushed stone were delivered at the lock site. Two hundred and fifty-six cubic yards of gravel were hauled from the bed of south slough, and 203 cubic yards gravel, 201 cubic yards of sand, and 60 cubic yards of crushed stone were hauled from the piles remaining at Lock 37.

The main north embankment opposite the lock and the cross bank just east of the lock were raised in preparation for high water, 1,503 cubic yards of earth being placed at a cost of $375.75. As soon as the weather would permit in the spring the pit was pumped out and construction of the walls commenced. The foundation was found to be in good condition. Erection of forming commenced at once, and depositing of concrete commenced April 18. The mixing and depositing of concrete was carried on continuously night and day until one wall was complete. The main walls contained 1,819.2 cubic yards, which was deposited in seven days, or at the rate of 86.6 yards per day of eight hours. The miter and breast walls, return walls at upper end, and abutments for pontoon bridge were built as soon as the forms were ready. The total amount of concrete masonry at Lock 36 is 2,141 cubic yards, costing $18,436.77, or $8.61 per cubic yard.

The proportions used in the concrete for this work were one part Portland cement, three parts gravel, and four parts broken stone. The facing and coping was composed of one part cement and two parts river sand. One cubic yard of finished concrete required 1.40 barrels cement.

Statement of cost of 2,141 cubic yards of concrete masonry at Lock 36.

3,010 barrels Portland cement	$9,057.45
1,252 cubic yards crushed stone	1,922.25
851 cubic yards gravel	664.17
500 cubic yards sand	888.61
Lumber for forming	281.65
Miscellaneous bills, fuel, lights, repairs, etc	253.36
Labor, building forms, warehouses, etc	1,472.09
Labor, mixing and placing concrete	3,897.19
Total	18,436.77

The oak and pine lumber for gates was obtained during the winter and framed ready for erection. As soon as the walls were ready the gates were erected and painted. The cross bank above the lock was taken out and grading back of walls commenced. Eight-inch tile were laid along the main walls at the bottom of the foundation and at foot of walls and joined to 12-inch tile passing through the walls above the floor just below lower gates.

Lock 37.—At the beginning of the year no work was in progress on this lock, the contract for the foundation having been annulled June 10, 1893, and the work taken possession of on that date. The work was left in charge of a watchman until August 1, when preparations were made for pumping out the pit and completing the foundation. The 20-horse-power engine that had been in use by the contractor being badly out of repair and the boiler much burned, a new 20-horse-power engine and boiler were purchased, with one 6-inch pump to replace the one worn out by the contractor, and two 9-inch pumps in addition. The old engine was also placed in running order. The engines and pumps were in position August 15, and pumping commenced. When the pit was dry it was found that a large amount of semifluid mud had been deposited in the bottom and that a large amount of earth had slid into the pit, especially on the south side, where the piling driven by the contractor to support the bank had been overturned by the earth pressure. The mud was taken out partly by the pump and partly by wagons, and the remainder of the pit excavated by shoveling into wagons. The pile driving was completed and the four rows of sheet piling driven across the foundation.

The pine timber for the grillage could not be found of the lengths called for in the plans, so shorter lengths were purchased in Davenport and delivered to the work by barge. This made a slight change in the plan of cross timbers necessary, but did not materially reduce the strength of the foundation. Broken stone was purchased in Moline and delivered by barge and placed under the foundation wherever the ground was soft. All springs were led out from under the foundation by lines of tile, which were connected with 10-inch tile laid outside of foundation. When the 10 by 10 inch longitudinal timbers had been bolted to the piles the space around the piles and up to the top of timbers was filled with concrete, consisting of one part Utica cement and three parts gravel.

The work of building the embankments in the fourth and fifth miles had shut off the water from the south slough, and had exposed a bar of fine silicious gravel, consisting of about 55 per cent coarse sand passing ½-inch mesh sieve and 45 per cent pebbles, only a small proportion of which would exceed 1 inch in diameter. This gravel was used in the foundation and formed a large part of the material for the walls themselves. The 10 by 10 and 6 by 10 cross timbers were then bolted to the longitudinals and the spaces between them filled with the same concrete.

A width of 25 feet, running entirely across the foundation under the lower gates, was excavated 28 inches below the tops of piles and filled with concrete, consisting of one part Utica cement and two and one-half parts gravel. An area under each hollow quoin, however, was filled with Portland cement concrete.

The total cost of completing the contract by hired labor was $7,428.07, while the estimates under the contract would have been $7,452.20. This estimate of cost does not take into account material on hand left by contractor and valued at $1,215.84; neither has charge been made for tools, engine and pumps, etc. There were placed in the foundation, by hired labor, 110 round piles, 63,383 feet B. M. pine timbers, 15,048 feet, B. M., pine plank, 11,415 feet B. M. oak plank, and 1,073.5 cubic yards concrete.

At first it was the intention to only complete the foundation during 1893, but the weather and stage of water proved very favorable for work in that locality, and the roads were excellent, so it was determined to carry forward the construction of the lock walls as far as possible.

The concrete-mixing machinery was moved from the guard lock and set up, and material for forming obtained. The framed timbers used at the guard lock were not long enough for the higher walls at Lock 37, and, as longer timbers could not be obtained, the vertical timbers were spliced, and an additional set of interior braces used. The lumber on hand at the guard lock was hauled by team and the additional lumber required delivered by barge. The crusher was run sixteen hours daily, and 1,060 cubic yards of crushed stone delivered by team; 1,450.8 cubic yards of crushed stone were also purchased in Moline and delivered by barge; 1,986 cubic yards of gravel was obtained by hired labor, and 374 cubic yards screened pebbles and 1,316 cubic yards of sand by informal contract.

The erection of the forming was pushed with a large force of carpenters, and as soon as enough material was on hand for one wall the depositing of concrete commenced. Three complete shifts of men were set at work, and the work of mixing and depositing concrete carried on continuously night and day until the south wall was completed. Some delay was caused by the cast iron hollow quoins not being on hand. The forming was then removed and erected for the north wall, which was built in the same way. The two walls contained 3,535.8 cubic yards of concrete, which required two weeks less eight hours for depositing, or at the average rate of 86.2 cubic yards per day of eight hours. This rate was not the capacity of the machinery, but was as fast as the concrete could be properly leveled and tamped in the forms.

The proportions first used in the concrete were one cement, four gravel, and five stone by measure, and the three sections comprising the straight portion of the south wall and the lower end section of the same wall were built of these proportions, but by your instructions these proportions were changed to one cement, three and one-third gravel, and four broken stone. The facing and coping was composed of one part cement and two parts clean river sand.

The miter and breast walls were built as soon as the forms could be removed from the north wall. The total amount of concrete in the walls is 3,767 cubic yards, costing $34,505.72, or $9.16 per cubic yard. A large amount of material remained on hand, however, for which the work should really be given credit. One yard of finished concrete required 1.21 barrels cement.

Statement of cost of 3,767 cubic yards of concrete masonry at Lock 37.

4,563¼ barrels Portland cement	$14, 181. 21
2,460 cubic yards crushed stone	4, 623. 85
2,000 cubic yards gravel	3, 139. 48
450 cubic yards sand	592. 20
Lumber for forming	1, 465. 82
Lumber for two storehouses	381. 04
Miscellaneous bills, fuel, lights, repairs, etc	1, 163. 82
Labor, building forms, storehouses, erecting mixer	2, 526. 00
Labor, pumping	264. 00
Mixing and placing concrete	6, 198. 30
Total	34, 505. 72

Ten-inch tile were laid along the main walls at the bottom of the foundation, and at the base of the walls, and connected with 12-inch tile passing through the walls above the floor just below lower gates. Broken stone was then placed over the tile and carried up back of the walls about 3 feet thick as the grading was done. Grading was carried up 12 feet back of south wall and 10 feet back of north wall, when freezing weather prevented further work.

During the winter the two engines and mixing machinery were moved to Lock 36, and set up. Everything of value that would be carried away by high water was hauled to Lock 36, and considerable quantities of sand, gravel, and stone remaining have been hauled to Lock 36 and to railroad crossing for use in masonry there.

During the winter the oak and pine lumber for the gates was obtained and framed ready for erection. The ironwork for gates has been inspected and delivered.

Fourth and fifth miles.—This work consists of the excavation of from 4 to 5 feet of earth overlying rock, using part of it to build necessary embankments on land, and transporting the remainder to build two heavy embankments in the river, forming the canal prism on the Milan front, and the excavation of from 4 to 5 feet of rock, and using it as riprap for the earthen embankments, and as material for concrete.

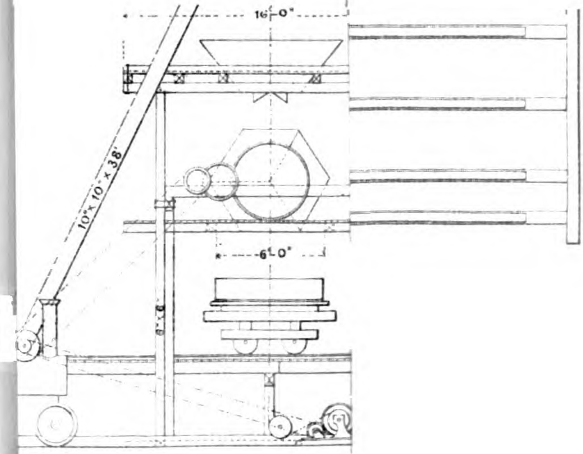
It was also necessary to excavate some material from between the river embankments, and to move a large sand bar at the head of Big Island. In all, 37,750 cubic yards of earth have been moved by scrapers and placed directly in embankments at a total cost of $5,110.47, or at a cost of $0.13½ per cubic yard. The rock cutting in the river bed varied from 4 to 18 inches in depth, and the excavation was necessarily very expensive, 1,579 cubic yards costing $5,347.98, placed as riprap on the embankments. Six thousand six hundred cubic yards of gravel, loose rock, sand, and mud were also excavated from the same place at a total cost of $3,914.31, or at a cost of $0.59 per cubic yard.

The earth for river embankments was loaded into rotary dump cars by means of wheeled scrapers passing over a trap, 86,432 cubic yards being loaded in this manner at a total cost of $14,807.37, or at a cost of $0.17 per cubic yard. The rock was excavated by drilling, blasting, and loading into cars, 25,914 cubic yards being excavated at a cost of $22,395.10, or at a cost of $0.86¼ per cubic yard. The transporting of the earth and riprap for the river embankments, 128,092 cubic yards, including pumping, engineering, and miscellaneous items, cost $7,225.75, or at the rate of $0.05⅝ per cubic yard. The haul varied from 2,000 to 8,000 feet. The unloading and placing of 128,092 cubic yards of earth and riprap, including the continual raising and repairing track, cost $8,972.42, or at the rate of $0.07 per cubic yard.

After the bridges of Rock Island and Peoria Railway had been raised, and the bed of south slough had been laid dry, a track was laid on the dry bed under the bridge, and continued along the north embankment in the second and third miles. By this means 3,861 cubic yards of riprap were hauled and placed on north side of north embankment west of the railway.

The rock to be excavated was very irregular, consisting mainly of limestone with many pockets of fire clay. The rock for concrete construction was obtained from this source, and all rock intended for crushing was sorted by hand. In all, 6,669 cubic yards were hauled to the crusher, yielding 5,887 cubic yards of screened stone.

As the progress of the work was limited by plant for transporting the material, two shifts of men and teams were worked during the summer of 1893, thus using the plant sixteen hours daily. During the past month two shifts have also been worked, rock excavation being done in the day, and earth work at night.



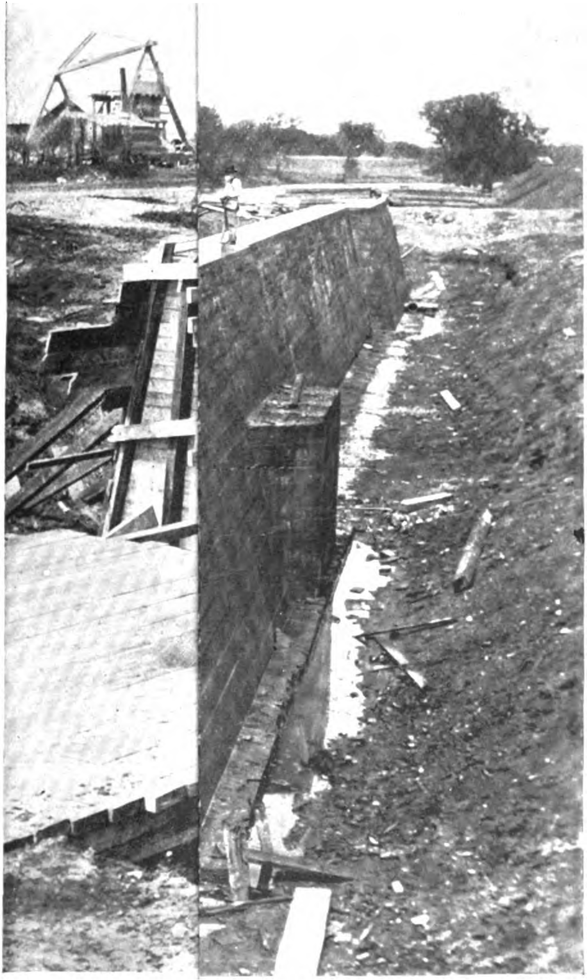
Front Elevatio

Drawn by PAUL HEINZE, C. E

ALD Co PHOTO-LITH., BALTO. MD.

Eng. 58 3.

PLATE 4.



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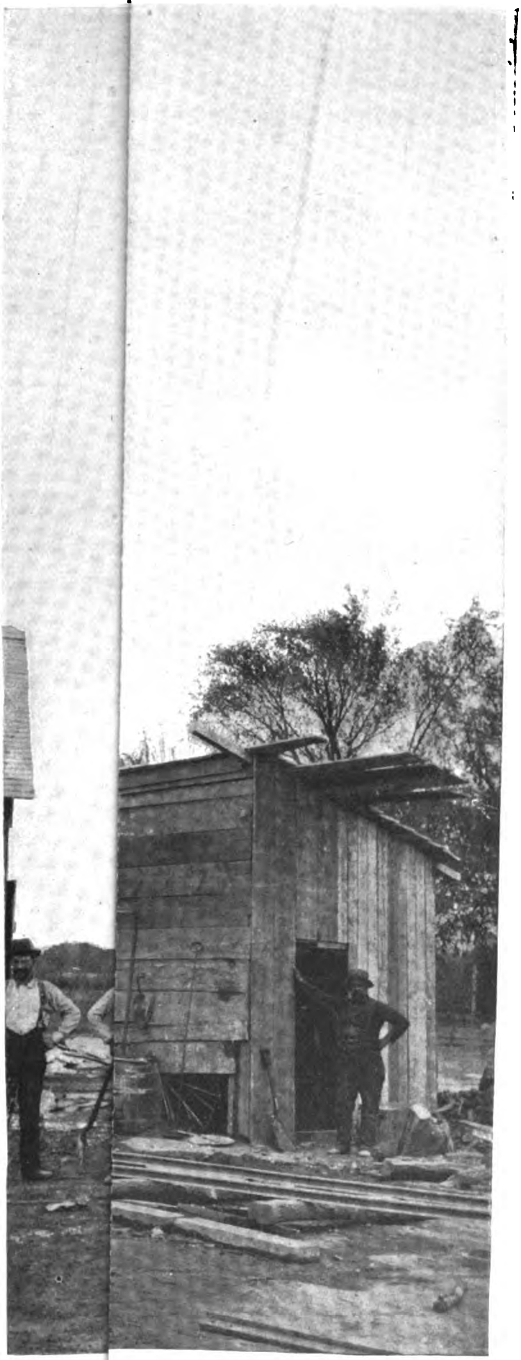

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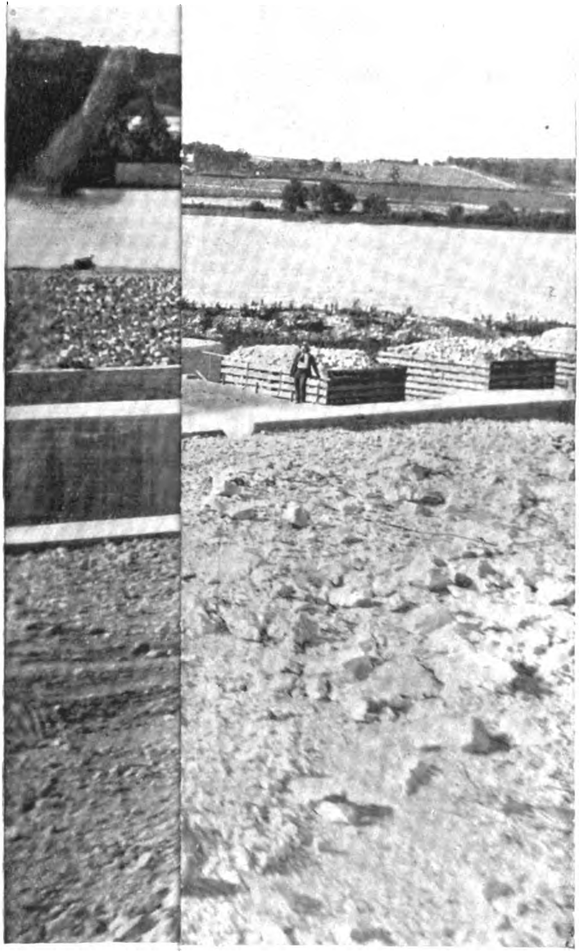

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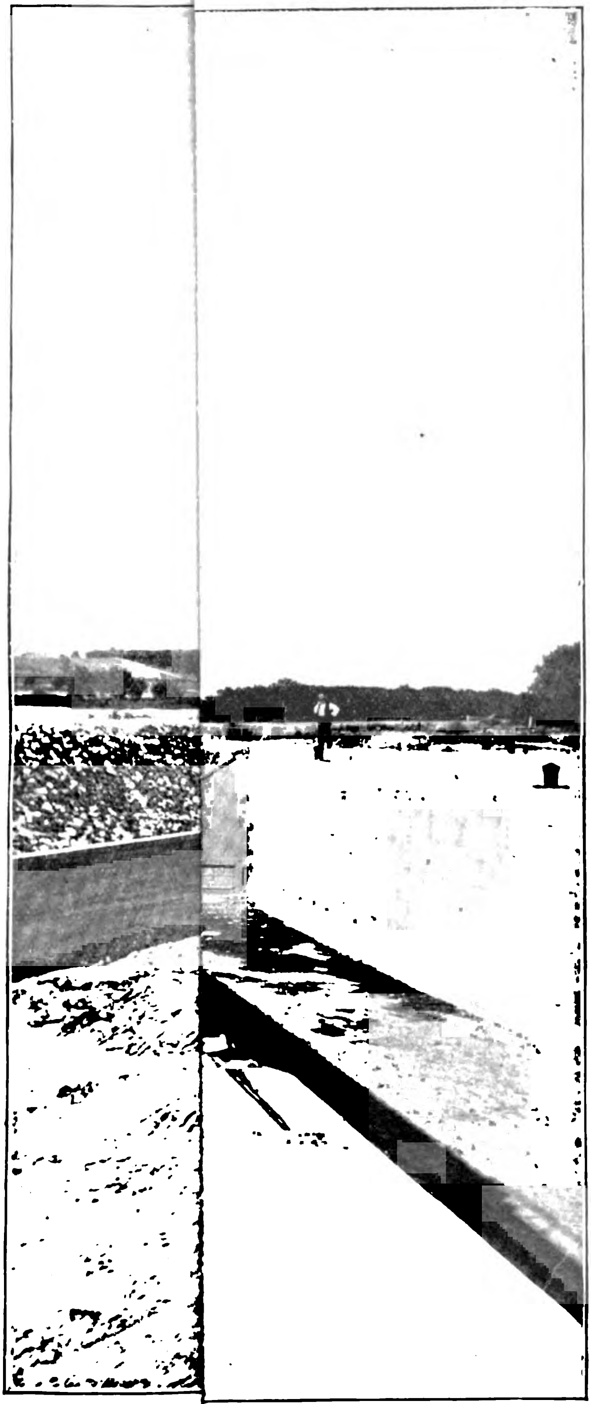

Ten 3-yard rotary dump cars, one 30-foot flat car, and one 6-wheeled locomotive, were added to the railway plant during the year.

At the mouth of Mill Creek four 21-foot Taintor sluice gates have been built for the purpose of passing water from the canal into south slough. The masonry for these gates consists of three piers 6 feet wide and 30 feet long, and two abutments with wing walls. The average height of the masonry is about 10 feet. Low cross walls join the piers and abutments, and furnish anchorage for the oak sills on which the gates rest. The concrete was mixed by shovels, and taken to the forms in wheelbarrows. The total cost of 460 cubic yards of concrete was $3,765.34, or at a cost of $8.19 per cubic yard. One cubic yard of concrete required 1.44 barrels of cement.

Statement of cost of 460 cubic yards of concrete masonry at Mill Creek sluice gates.

664 barrels Portland cement	$1,958.80
253 cubic yards crushed stone	141.50
116 cubic yards screened pebbles	150.80
214 cubic yards sand	193.00
Miscellaneous bills	84.24
Carpenter work on forms	358.91
Mixing and placing concrete	878.09
Total	3,765.34

The gates are 21 feet wide and 8 feet high. The cost of the four gates is as follows:

Lumber	$605.86
Iron, including hoisting carriage	725.90
Labor	661.46
Paint and painting	67.85
Miscellaneous bills	90.30
Total	2,151.37

Bridges.—At the railway crossing 2,192 cubic yards of grading for a turnout has been done. The turnout for the street railway at the highway crossing has also been graded. A warehouse has been moved to site of the bridges, and 1,500 barrels of cement received for the construction. There have been hauled from the crusher 938 cubic yards of crushed stone, and from Lock 37, 178 cubic yards of sand for facing. A gravel pump was used to pump 766 cubic yards of screened pebbles from south slough, which were hauled to the site by wagon.

In accordance with the finding of the court of condemnation, the Rock Island and Peoria Railway have raised their two bridges adjacent to the canal and the grade of track between them about 3 feet.

Dams.—Three of the abutments had been built in the preceding year, and the fourth was built in connection with the masonry at guard lock. During the winter and spring the oak and pine lumber and iron for both dams were purchased and delivered.

Rock River during the spring has been at a low stage, and it was therefore determined to make an early start on dam construction. An area on the main north shore was stripped of earth, and early in June an earth cofferdam across north channel was commenced by teaming quarry stripping into the river. Five 16-foot cribs 14 feet apart were sunk on south side to serve as sluiceways when making the final closure. The greatest depth of water was 5 feet. No trouble was experienced in building the cofferdam entirely across with wagons, and it proved to be very tight, except in the vicinity of the cribs. The bed was then laid entirely dry by inclosing limited areas with secondary dams and pumping out the water with hand pumps. All loose material was then cleared away. Some deep pockets of fire clay were found, but were dug out and filled with crib work and stone. It is proposed to build the dam up to purlines, and then allow the entire discharge of the stream to flow over the incomplete work while the south dam is being built. At the end of the fiscal year 450 feet of the dam had been built up to that stage and the entire foundation laid dry.

During the year I have been ably assisted by Messrs. J. W. Woermann, A. O. Rowse, and Geo. T. McGee, and my thanks are due all these gentlemen for the interest and zeal they have shown in the work. Mr. Woermann has kept a complete photographic record of the work in addition to his other duties.

Very respectfully, your obedient servant,

L. L. Wheeler,
Assistant Engineer.

Capt. W. L. Marshall,
Corps of Engineers, U. S. A.

REPORT OF MR. JAS. C. LONG, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Tiskilwa, Ill., June 30, 1894.

CAPTAIN: I have the honor to submit a report of operations by the party under my charge, on the eastern section of the Illinois and Mississippi Canal, during the fiscal year ending June 30, 1894.

At the beginning of the year the party consisted of two instrument men, a rod man, and six men, in the field, and two draftsmen, a receiver of material, and a messenger, in the office.

Work done by field party.—The party in the field had just begun nine days before, and had progressed fifteen miles on a new survey for a canal line; from the Feeder Junction at mile 25, to Rock River at the mouth of Green River, near Colona, Ill., and continued the same to completion on July 24, 1893. This survey was made for a comparison with a line previously surveyed, and known as the Penneys Slough route. By the Penneys Slough route the crossing of Green River was difficult. Quoting from your report of 1890: "The stream has very low banks, and consequently will not admit of damming to allow the canal to cross it at the same level, while at the same time the configuration of the country is such that the canal levels can neither be advantageously raised to secure sufficient head room under the aqueduct trunk, nor lowered to attain the normal mid-stage level of the river. High water in Green River consequently reaches nearly to the water level in the aqueduct trunk, and it must be passed under the aqueduct on an invert." By this survey a good crossing of Green River was secured, where a head room of 3 feet between high-water mark and the aqueduct trunk was obtained, and a saving of 1.8 miles in distance was made.

The comparative estimates of the two routes are herewith attached. The estimates for the Penneys Slough route in the same were taken from your report of 1890.

This survey began at mile 25, terminated at mile 62.3, was therefore 37.3 miles in length. Fifteen miles of this line were run during the last nine days of last year; but all of the estimates, maps, profiles, etc., pertaining to it were made during this fiscal year.

On July 25, 1893, the field party was moved back to Wyanet, where two days were employed in re-marking the line from miles 12 to 16 for the purpose of taking the topography again, as it was done imperfectly in the first instance. On July 27, 1893, the field party was moved back to Bureau Junction, Ill., where, until August 4, they were employed in locating stations, 150 feet apart, on both banks of the Illinois River, 900 feet above and 900 feet below the canal entrance, for the purpose of sounding the river. Stations were located in the same manner at Spring Lake, 600 feet above and 600 feet below the canal, for the purpose of taking soundings there also.

Forty-five stations were located and 2,445 soundings taken. During this time the level man and two men were employed in retaking topography on miles 12 to 16.

On the 5th of August the party began locating the corners of tracts of land required for canal purposes and to build mounds of earth to mark and preserve the same. These mounds are 6 feet in diameter, 2 feet high, and 3 feet across the top, with a stake in the center. It is thought that ordinary ploughing will not obliterate such marks. The work of surveying tracts of land and building of mounds was continued until October 18, when it was completed to mile 25. One hundred and ninety-four corners of land tracts were located and 538 mounds were built. Some of these mounds also marked changes in width of right of way.

Cross-section work.—On October 19 began the work of remarking the line, so as to take cross sections of the ground upon which the canal is to be built, the stakes that had previously been set to mark the line having all been destroyed by the land owners in plowing their crops, etc. This was done by driving hardwood hubs about 4 inches in diameter and 15 inches long at the stations in the center line, which are 100 feet apart, with a stake as marker alongside the hub. The same kind of hubs and stakes were driven along the line of right of way, on both sides and at right angles to those in the center line, for the purpose of marking line of cross sections to be taken. Check levels were then run over the center line, the levels being taken on the tops of these hubs, which were driven flush with the ground. Cross sections of the ground were then taken on both sides of the center line, to the limits of the right of way, at stations and at intermediate points where the configuration of the ground required it, in order to correctly calculate the excavation and embankment that would be made in constructing the canal:

This work was pushed forward continuously, except a few days while the party was making some minor surveys in connection with tracts of land required for right of way, until May 10, when it was completed. From October 19 to January 15 two instrument men were kept at work, but after January 15 the services of one instrument man was dispensed with. During this time 25 miles of center line was re-marked by hubs and stakes; 25 miles of line on each side of right of way was marked in the same way, making 75 miles of line re marked. Twenty-five miles of check levels were run over center line. Two thousand five hundred and eight cross sections were taken, and as the right of way will average 300 feet in width and the cross sections were taken the full width of right of way, the length of each would average 300 feet, and total length of cross sections would be 142.5 miles.

On May 14 the men engaged on cross-section field work were discharged, and the instrument man was brought into the office to assist in calculating the areas of cross sections and cubic yards of earthwork.

Borings.—On February 19, 1894, a party consisting of a rodman and two men were put to work with a 2-inch auger to make borings to determine the character of lock foundations, foundations of culverts, and material to be excavated along the trunk of the canal. This work was continued until June 15, when the total number of borings made amounted to 769. The following are sample borings made on the first 8 miles of the canal. The material brought up by the auger was arranged in glass tubes 1 inch in diameter, and on a vertical scale of 1 inch=1 foot, and will be kept for future reference:

	Feet.
Mile 1:	
Loam	3.4
Clayey loam	6.9
Sandy clay	2.4
Quicksand	3.3
Total	16
Mile 2:	
Loam	1.9
Clay	1
Clay and gravel	1.1
Clay	3.2
Soft clay	2.8
Total	10
Mile 3:	
Loam	3.9
Clay	4
Quicksand	4.1
Total	12
Mile 4:	
Sandy loam	3.9
Clay	2.4
Quicksand	1.7
Total	8
Mile 5:	
Loam	3.6
Clay	2.2
Quicksand	4.2
Total	10
Mile 6:	
Loam	3.4
Clay	1.6
Quicksand	4.8
Total	9.8
Mile 7:	
Hard dry loam	2.4
Clay and gravel	3
Clay	5.6
Quicksand	2.5
Total	13.5
Mile 8:	
Loam	1.9
Clay	1.9
Sandy clay	2
Sand	2
Soft clay	1.8
Sand and gravel	1.9
Total	11.5

	Feet.
Lock 1:	
Loam	3.7
Yellowish clay	5.1
Sandy clay	1.2
Soft sandy clay	4
Blue clay	4
Total	18
Lock 2:	
Loam	2.7
Clay and gravel	1
Clay, sand, and gravel	1.5
Hard clay and gravel	3.8
Tough clay and gravel	4
Total	13
Lock 3:	
Loam	3.5
Clayey loam	1.4
Soft mud and sand	2.3
Coarse gray sand	4.8
Total	12
Lock 4:	
Dry sandy loam	4.5
Wet sandy loam	1
Sandy clay	1
Quicksand	2.5
Sand and gravel	7
Total	16
Lock 5:	
Loam	2.6
Clay	3.2
Gray sandy clay	1.2
Gray sand	2
Sand and gravel	3
Total	12
Lock 6:	
Loam	2.6
Soft clay	2.4
Sandy clay	2.6
Sand	1.4
Soft gray clay	4
Total	13
Lock 7:	
Loam	3.9
Sand	3.7
Quicksand	1.9
Sand and gravel	5.5
Total	15

Permanent bench marks.—While engaged in boring, the boring party put in 53 permanent bench marks up to this date. These bench marks were made by sinking into the ground a piece of tile pipe 2 feet long and 1 foot in diameter; after tamping the earth well around the pipe it was filled with cement mortar, composed of one part cement and two parts sand, with a piece of three-fourths-inch round iron embedded in it to a depth of 1 foot, one end projecting one-half inch above the mortar upon which to take the levels.

Work in the office.—Topographical maps of the located line have been completed in 4-mile sections as far as mile 24, and blue-prints of same forwarded to the Chicago office.

A map of the preliminary line from the end of mile 25 to mile 62.3, on Rock River, on a scale of 1 inch = 600 feet, has been platted, showing topography and section lines. Some work is yet required on this map in the way of lettering and inking in pencil lines to complete it. A map showing the above preliminary line and the Penneys Slough line was platted on a scale of 1 inch = 5,000 feet, and blue-prints forwarded to the Chicago office on November 22, 1893. Profiles in duplicate and approximate estimate of cost of this line were also made and forwarded to the Chicago office on same date as the blue-prints.

Index maps of the right of way, showing ownership of land required, have been completed in 4-mile sections as far as mile 24, blue-prints of the same made, and each tract colored and numbered to agree with the number of the plat and description.

Six prints of each map have been forwarded to the Chicago office.

Eighty-one plats and descriptions of land required for right of way were made, completing this work as far as mile 24.7, and with the exception of those tracts on the last 0.7 mile, 4 blue-prints and copies of description of each have been sent to the Chicago office.

The following maps were prepared for use in the U. S. district court at Chicago during the trial of suits for the condemnation of lands required for right of way.

One map from mile 0 to mile 4 and 1 map from mile 4 to mile 8, showing ownership of land passed over and the area of small tracts cut off from main bodies by the canal.

Two maps showing 4 miles each from mile 8 to mile 16 on a scale of 1 inch = 300 feet.

The following maps were made and blue-prints of the same forwarded to the Chicago office: 1 map of soundings made in the Illinois River and Spring Lake; 1 map of proposed location of Lock No. 4 and Aqueduct No. 1; 1 map of proposed change of creek channel on mile 5; 2 maps in 4-mile sections, showing proposed location o' canal embankments from mile 0 to mile 8.

Profiles have been made in duplicate of the line from mile 0 to mile 24; also a profile from mile 0 to mile 8 on a large vertical scale, showing the material developed by borings along center line at intervals of one-eighth of a mile.

Seven maps were made for the use of the field party in locating land lines, boundaries of the right of way and individual tracts of land.

The field notes of the cross-section party, as far as mile 16, have been reduced and checked in the office.

Cross sections of the right of way have been platted as far as mile 14.2, and estimates of earthwork, material in lock foundations and culverts on first 8 miles, made and forwarded to Chicago office.

Cross sections of the right of way, at proposed sites of locks and culverts on the first 8 miles have been made, showing the material developed by borings.

Six hundred and ninety-two blue-prints were made during the year.

Agreements to sell land.—Agreements to sell land to the United States were obtained from 34 landowners; 8 landowners were nonresidents and could not be interviewed, and 4 refused to sign agreements.

On January 25, 1894, sent communications to all landowners between miles 8 and 24, inclosing tables showing awards made by the juries in the U. S. court at Chicago, in condemning lands required for the right of way from mile 0 to mile 8. Also extracts from your letter of January 5, 1894, allowing propositions previously made to be withdrawn, and new ones substituted, more in accord with the values as shown by the above-mentioned awards. Afterwards all of these land owners were interviewed with a view to receiving new propositions. A number of new propositions were received and forwarded to the Chicago office, together with a tabular statement showing the new propositions as compared with the old ones, and whether new ones were made or not.

Abstracts of land titles.—Thirty-four abstracts of titles to land required by the United States for the right of way were received from the abstractors at Princeton, Messrs. Tindale & Son, and Joe A. Davis, and after being checked and examined in this office were forwarded to the Chicago office.

Miscellaneous work.—Made observations for true meridian at Tiskilwa, Ill., and determined the variation of the compass to be 4° 48′ east. Three miles of section lines resurveyed for correction. Located 7 highway crossings. Located road from lock-keeper's dwelling on mile 17 to public highway 0.3 miles long. Located 2 quarter-section corners in section 20, township 16 north, range 8 east of the fourth principal meridian. Located 1 section and 5 quarter-section corners in section 8, township 16 north, range 8 east of the fourth principal meridian. Located 1 section and 2 quarter-section corners in section 10, township 16 north, range 7 east of the fourth principal meridian. Located 1 section and 4 quarter-section corners in section 5, township 16 north, range 7 east of the fourth principal meridian. Survey made of additional land required for right of way on mile 5 and designated as Plat 21a. Survey made of additional land required for right of way on mile 10 and designated as Plat 46a; also cross-sectioned the same. Detail survey made of locality at East Bureau Creek on mile 4, for location of Lock No. 4 and Aqueduct No. 1. Located and cross-sectioned a new creek channel on mile 5. Changed center line of canal from mile 3 to mile 3.8 to adapt it to location of Aqueduct No. 1.

Employés.—Mr. J. D. Truss, transit man, was in charge of the field work during the whole year, except five days at U. S. court in Chicago in connection with suits for condemnation of right of way, and from May 14 to June 30 engaged in the office assisting in circulating areas of cross sections and quantities of earthwork, etc.

Mr. H. L. Parker, level man, was employed from the beginning of the fiscal year until January 15, 1894, and during that time was engaged on field work except when assisting in the office on notes, etc., connected with the survey from feeder junction to Green River, from September 28 to October 31, 1893, and three days at the U. S. court at Chicago.

Mr. S. L. Bayless, instrument man, reported for duty on May 17, 1894, and was put to work in the office assisting in calculating areas of cross sections and quantities of earthwork, etc., which work he has been engaged on up to date.

Mr. Charles A. Browne, draftsman, has had charge of the work in office and has been employed there during the whole year except when absent as follows: On duty in the field nineteen days, and at Princeton and Chicago, in connection with the work of securing right of way, sixteen days.

Mr. Thomas H. Joy, assistant draftsman, was employed in the office the whole year, with the exception of ten days when he was acting as transit man with field party in place of Mr. Truss, who was absent or sick.

Mr. William D. Ott, receiver of material, has been employed during the year in general office work and in writing descriptions of land and agreements to sell land, and in visiting landowners to negotiate with them for the sale of land to the United States for canal purposes.

Mr. J. E. Thompson, rod man, was employed during the whole year with the party in the field, except when employed visiting landowners to have them sign agreements to sell land to the United States for canal purposes, and when in charge of boring party.

I have the honor to be, your obedient servant,

Jas. C. Long,
Assistant Engineer.

Capt. W. L. Marshall,
Corps of Engineers, U. S. A.

Tiskilwa, Ill., *October 21, 1893.*

Captain: I have the honor to forward herewith tabular statements and comparative estimates of the Illinois and Mississippi Canal from mile 25 westward to the mouth of Green River by two routes, one by the route surveyed by me in June and July, 1893, and the other by the Penneys Slough route.

I reported an estimate of the route surveyed by me on September 22, 1893, but to make that estimate more complete for a comparison with the Penneys Slough route, I have added other items, viz: Slope wall, $28,637; right of way, $49,651; fencing, $23,872; special damages, $19,500.

For the reason that no estimate for work of that character had been made on my survey, I drop the item of concrete lining from the estimate via Penneys Slough route, amounting to $58,000. The estimates compare as follows:

Mile.	Penneys Slough route.	Route of 1893.	Mile.	Penneys Slough route.	Route of 1893.
26	$70,892	$46,994	47	$20,070	$75,992
27	71,004	36,795	48	137,400	26,684
28	30,570	20,686	49	122,572	84,715
29	24,850	71,566	50	28,980	44,855
30	34,530	24,978	51	62,438	30,814
31	81,638	30,421	52	13,935	76,406
32	72,725	23,768	53	9,585	18,709
33	16,020	22,756	54	7,575	25,682
34	14,510	30,219	55	7,860	42,693
35	23,140	32,191	56	5,472	62,971
36	19,570	40,143	57	4,080	41,365
37	19,420	21,869	58	3,526	65,726
38	114,636	104,984	59	141,537	25,020
39	19,420	29,707	60	10,578	54,648
40	27,850	35,589	61	7,582	60,929
41	23,570	33,654	62	5,421	104,296
42	10,980	32,319	63	6,813	
43	28,280	31,679	64	145,538	
44	30,150	33,810			
45	30,130	114,565	Total	1,535,937	1,689,781
46	31,090	29,583			

It will be seen that the route via Penneys Slough foots up $153,844 less than the route of 1893, on account of having no culverts, land damages, fencing, or spillways to provide for on the last 13 miles. Also the route of 1893 provides for two railway bridges, while the Penneys Slough route provides for none.

Respectfully submitted.

JAS. C. LONG,
Assistant Engineer.

Capt. W. L. MARSHALL,
Corps of Engineers, U. S. A.

Itemized estimate of probable cost of Illinois and Mississippi Canal from mile 25 to mile 62.3, from a survey made June and July, 1893.

Mile.	Earthwork.				Locks.			Keeper's dwellings.
	Embankment.		Excavation.					
	Cubic yards.	Cost.	Cubic yards.	Cost.	No.	Lift.	Cost.	
						Feet.		
26	57,919	$8,688	46,110	$6,916				
27	30,384	4,558	63,786	9,568				
28	63,234	9,485	17,682	2,652				
29	47,820	7,173	44,708	6,706	1	8	$40,000	$2,500
30	69,348	10,402	12,904	1,936				
31	90,017	13,503	1,305	196				
32	104,364	15,655						
33	119,498	17,925						
34	113,859	17,079						
35	119,915	17,987						
36	85,348	12,802	13,859	2,079				
37	29,595	4,439	81,013	12,152				
38	59,760	8,964	31,345	4,702	1	8	40,000	2,500
39	54,879	8,232	44,174	6,626				
40	53,516	8,027	39,806	5,971				
41	31,187	4,678	93,035	13,955				
42	52,446	7,867	54,953	8,243				
43	49,058	7,359	39,997	6,000				
44	77,285	11,593	46,816	7,022				
45	171,751	25,764	6,145	922				
46	38,446	5,767	51,431	7,715				
47	71,995	10,799	17,849	2,677	1	8	40,000	2,500
48	20,584	3,088	81,436	12,215				
49	37,640	5,646	60,429	9,064	1	10	48,500	2,500
50	45,121	6,768	41,367	6,205				
51	53,412	8,012	24,858	3,729				
52	71,242	10,686	22,165	3,325	1	10	48,500	2,500
53	14,268	2,140	96,798	14,520				
54	44,214	6,632	41,669	6,250				
55	76,743	11,511	17,434	2,615				
56	31,214	4,682	65,143	9,771	1	8	40,000	2,500
57	47,280	7,092	38,568	5,785				
58	61,099	9,165	29,458	4,419	1	8	40,000	2,500
59	21,130	3,169	77,916	11,687				
60	28,420	4,263	64,013	9,602				
61	38,622	5,793	111,945	16,792				
62.3	98,423	14,763	31,862	4,779	2	7	76,000	2,500
Total	2,281,036	342,156	1,511,979	226,796	9		373,000	20,000

Itemized estimate of probable cost of Illinois and Mississippi Canal from mile 25 to mile 62.3, from a survey made June and July, 1893—Continued.

Mile.	Aqueducts.			Sluices, inflows, weirs, and spillways.				Cost of slope wall.	Culverts.		
	No.	Length.	Cost.	No.	Kind.	Length.	Cost.		No.	Kind.	Cost.
		Feet.				*Feet.*					
26				1	Paved ..	300	$5,000		3	Arch..	$18,132
27				1	...do	300	5,000		3	...do ..	8,911
28									1	...do ..	6,091
29									2	...do ..	5,612
30				1	Paved ..	300	5,000		1	...do ..	6,091
31									2	...do ..	9,373
32									1	...do ..	6,564
33									1	...do ..	3,282
34				1	Paved ..	300	5,000		1	...do ..	6,091
35									3	...do ..	12.655
36				1	Paved ..	300	5,000	$1.162	3	...do ..	10.751
37									2	...do ..	2,820
38	1	150	$40,000					560			
39									1	Arch..	6,091
40									2	...do ..	12,182
41									2	...do ..	5,612
42											
43									3	Arch..	8,911
44									3	...do ..	6,102
45	1	300	75,000	1	Paved ..	300	5,000	2,562	1	...do ..	3,282
46									2	...do ..	4 692
47									2	...do ..	6,564
48									2	...do ..	2,820
49				1	Paved ..	300	5,000		1	...do ..	12,182
50				1	...do	300	5,000	2,331	3	...do ..	10,751
51									4	...do ..	11,224
52									3	...do ..	9,846
53											
54									3	Arch..	10,751
55				1	Paved ..	300	5,000	3,885	2	...do ..	12,182
56								1,036	1	...do ..	3,282
57				1	Paved ..	300	5,000	11,508	3	...do ..	8,894
58									3	...do ..	7,942
59								1,862	3	...do ..	6,102
60								3,731	4	...do ..	9,352
61									2	...do ..	4,692
62.3									2	...do ..	3,740
Total ..	2		115,000	10			50,000	28,637	75		263,569

Itemized estimate of probable cost of Illinois and Mississippi Canal from mile 25 to mile 62.3, from a survey made June and July, 1893—Continued.

Mile.	Bridges.						Right of way.				Total.
	Highway.		Railway.				Acres.	Cost.	Cost of fencing.	Special damages.	
	No.	Cost.	No.	Span.	Kind.	Cost.					
				Feet.							
26	1	$5,800	......	......	......	......	30.3	$1,818	$640	......	$46,994
27	1	5,800	......	......	......	......	30.3	1,818	640	$500	36,795
28	......	......	......	......	......	......	30.3	1,818	640	......	20,686
29	1	5,800	......	......	......	......	30.3	1,635	640	1,500	71,566
30	......	......	......	......	......	......	30.3	909	640	......	24.978
31	1	5,800	......	......	......	......	30.3	909	640	......	30,421
32	......	......	......	......	......	......	30.3	909	640	......	23,768
33	......	......	......	......	......	......	30.3	909	640	......	22,756
34	......	......	......	......	......	......	30.3	909	640	500	30,219
35	......	......	......	......	......	......	30.3	909	640	......	32,191
36	1	5,800	......	......	......	......	30.3	909	640	1,000	40,143
37	......	......	......	......	......	......	30.3	1,818	640	......	21,869
38	1	5,800	......	......	......	......	30.3	1,818	640	......	104,984
39	1	5,800	......	......	......	......	30.3	1,818	640	500	29,707
40	1	5,800	......	......	......	......	30.3	1,969	640	1,000	35,589
41	1	5,800	......	......	......	......	30.3	1,969	640	1,000	33,654
42	2	11,600	......	......	......	......	30.3	1,969	640	2,000	32,319
43	1	5,800	......	......	......	......	30.3	1,969	640	1.000	31,679
44	1	5,800	......	......	......	......	30.3	1,653	640	1,000	33,810
45	......	......	......	......	......	......	30.3	1,395	640	......	114,565
46	1	5,800	......	......	......	......	30.3	1,969	640	3,000	29,583
47	2	11,600	......	......	......	......	30.3	1,212	640	......	75,992
48	1	5,800	......	......	......	......	30.3	2,121	640	......	26,684
49	......	......	......	......	......	......	30.3	1,183	640	......	84,715
50	2	11,600	......	......	......	......	30.3	1,060	640	500	44,855
51	1	5,800	......	......	......	......	30.3	909	640	500	30,814
52	......	......	......	......	......	......	30.3	909	640	......	76,406
53	......	......	......	......	......	......	30.3	909	640	500	18,709
54	......	......	......	......	......	......	30.3	909	640	500	25,682
55	1	5,800	......	......	......	......	30.3	1,060	640	......	42,693
56	......	......	......	......	......	......	30.3	1,060	640	......	62,971
57	......	......	......	......	......	......	30.3	946	640	1,500	41,365
58	......	......	......	......	......	......	30.3	1,060	640	......	65,728
59	......	......	......	......	......	......	30.3	1,060	640	500	25,020
60	......	......	1	60	Pivot	$25,000	30.3	1,060	640	1,000	54,648
61	1	5,800	1	60	...do	25,000	30.3	1,212	640	1,000	60,929
62.3	......	......	......	......	......	......	39.4	1,182	832	500	104,296
Total	22	127,600	2	......	......	50,000	1,130	49,651	23,872	19,500	1,689,781

Itemized estimate of probable cost of Illinois and Mississippi Canal from mile 25 to mile 64.1, from the survey via Penneys Slough.

Mile.	Earthwork.		Locks.				Aqueducts.			Dams.			
	Cubic yards.	Cost.	No.	Lift.	Cost.	Keeper's dwelling.	No.	Length.	Cost.	No.	Kind.	Length.	Cost.
26	58,100	$11,620	1	7	$40,812	$2,500							
27	62,750	12,550	1	6	38,654	2,500							
28	65,650	13,130											
29	73,050	14,610											
30	61,950	12,390											
31	133,950	26,790	1	8	42,468	2,500							
32	76,150	15,230	1	9	44,635	2,500							
33	62,650	12,530											
34	55,100	11,020											
35	64,500	12,900											
36	58,400	11,680											
37	56,150	11,230											
38	57,150	11,430					1	420	$102,066				
39	79,400	15,880											
40	79,050	15,810											
41	50,900	10,180											
42	47,950	9,590											
43	95,700	19,140											
44	101,000	20,210											
45	73,700	14,740											
46	79,750	15,950											
47	67,400	13,480											
48	111,850	22,370	1	10	48,568	2,500							
48			1	10	46,574	2,500							
49	70,850	14,170	1	6	38,654	2,500							
49			1	10	48,568	2,500							
50	69,600	13,920											
51	75,800	11,370	1	10	48,568	2,500							
52	92,900	13,935											
53	63,900	9,585											
54	50,500	7,575											
55	52,400	7,860											
56	36,480	5,472											
57	27,200	4,080											
58	16,840	2,526											
59	33,420	5,013	1	5	64,414	2,500				1	Pile.	713	$69,560
60	70,520	10,578											
61	43,880	6,582											
62	36,140	5,421											
63	31,420	4,713											
64.1	11,153	11,153	1	3	58,116	2,500				1	Crib.	682.5	72,619
Total.	2,455,253	468,413	11		520,031	27,500	1		102,066	2			142,179

Itemized estimate of probable cost of Illinois and Mississippi Canal from mile 25 to mile 64.1, from the survey via Penneys Slough—Continued.

Mile.	Sluices, inflows, weirs, and spillways.				Culverts.		Highway bridges.		Right of way.				
	No.	Kind.	Length.	Cost.	No.	Cost.	No.	Cost.	Acres.	Cost.	Cost of fencing.	Special damages.	Total.
26					2	$6,100	2	$7,400	26	$1,820	$640		$70,832
27	1	Paved.	300	$5,000	1	6,500	1	1,600	26	1,560	640	$2,000	71,004
28					1	6,500	1	5,800	25	1,500	640	3,000	30,570
29					2	6,100			25	1,500	640	2,000	24,850
30	1	Paved.	300	5,000	2	13,000			25	1,500	640	2,000	34,530
31							1	5,800	26	1,440	640	2,000	81,638
32	1	Paved.	300	5,000	1	2,600	1	1,600	26	520	640		72,725
33					1	2,600			25	250	640		16,020
34					1	2,600			25	250	640		14,510
35					2	9,100			25	500	640		23,140
36					1	6,500			25	750	640		19,570
37							1	5,800	25	1,250	640	500	19,420
38									25	500	640		114,636
39					1	2,400			25	500	640		19,420
40					1	3,100	1	5,800	25	500	640	2,000	27,850
41					1	12,000			25	750	640		23,570
42									25	750	640		10,980
43					2	4,500			25	1,000	640	3,000	28,280
44							1	5,800	25	1,500	640	2,000	30,150
45					1	7,700	1	5,800	25	250	640	1,000	30,130
46					1	7,700	1	5,800	25	1,000	640		31,090
47					1	3,700			25	750	640	1,500	20,070
48	1	Paved.	300	5,000					30	1,200	640	1,000	137,400
48	1	Stone.	54	7,048									
49	1	Paved.	300	5,000	1	2,600	2	7,400	27	540	640		122,572
49													
50	1	Paved.	300	5,000	1	3,100	1	5,800	26	520	640		28,980
51													62,438
52													13,935
53													9,585
54													7,575
55													7,860
56													5,472
57													4,080
58												1,000	8,526
59									1	50			141,537
60													10,578
61												1,000	7,582
62													5,421
63												2,100	6,813
64.1									1	50		1,100	145,538
Total.	7			37,048	24	108,400	14	64,400	639	22,790	16,000	27,200	1,535,937

APPENDIX L L.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN MICHIGAN, AND OF MICHIGAN CITY HARBOR, INDIANA.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, LIEUT. COL. G. J. LYDECKER AND MAJ. WILLIAM LUDLOW, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Michigan City Harbor, Indiana.
2. St. Joseph Harbor, Michigan.
3. St. Joseph River, Michigan.
4. South Haven Harbor, Michigan.
5. Saugatuck Harbor, Michigan.
6. Holland (Black Lake) Harbor, Michigan.
7. Grand Haven Harbor, Michigan.
8. Muskegon Harbor, Michigan.
9. White Lake Harbor, Michigan.
10. Pentwater Harbor, Michigan.
11. Ludington Harbor, Michigan.
12. Manistee Harbor, Michigan.
13. Harbor of refuge at Portage Lake, Manistee County, Michigan.
14. Frankfort Harbor, Michigan.
15. Charlevoix Harbor and entrance to Pine Lake, Michigan.
16. Petoskey Harbor, Michigan.
17. Cheboygan Harbor, Michigan.
18. Alpena Harbor (Thunder Bay River), Michigan.
19. Saginaw River, Michigan.
20. Harbor of refuge at Sand Beach, Lake Huron, Michigan.
21. Black River at Port Huron, Michigan.
22. Mouth of Black River, Michigan.
23. Clinton River, Michigan.
24. Rouge River, Michigan.
25. Turning basin in Rouge River, Michigan.
26. Removing sunken vessels or craft obstructing or endangering navigation.

HARBOR LINES.

27. St. Joseph Harbor, Michigan.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 18, 1894.

GENERAL: I have the honor to submit herewith the annual reports relative to the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

L L 1.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

Operations for the improvement of this harbor have been in progress since 1836, and have been directed toward the construction of (1) the inner harbor, and (2) the outer harbor.

1. *The Inner Harbor.*—The work done under this head comprises (*a*) that originally projected for facilitating entrance to Trail Creek, by constructing revetments and piers, 100 to 225 feet apart, extending along the lower reach of the creek and far enough into Lake Michigan to protect the channel dredged between them; and (*b*) that now in progress, for prolonging the entrance channel to the upper limit of the creek, between revetments from 125 to 175 feet apart constructed at the expense of the adjoining property. The former, or original project, was the subject of all work done from 1836 to 1869 inclusive, when the piers reached to 12 feet of water in Lake Michigan, and a good entrance channel was available to vessels drawing 11 feet. From that time to 1882 nothing was done on the inner harbor except to make occasional repairs to the piers and keep the needed channel depth between them by dredging. In 1882 the scope of interior operations was extended to prolonging the channel upstream by dredging, so far as riparian owners constructed revetments of approved design. The total length of improved channel at the beginning of the last fiscal year was 9,159 feet. It was not extended during the year, but the depth was increased where it had shoaled below 12 feet by dredging to the extent of 27,231 cubic yards during the year; 1775 yards were excavated between November 27 and December 2, when the plant was laid up for the winter, and the remainder (25,456 cubic yards) was excavated between April 17 and the end of the fiscal year; all by the United States dredge *Michigan City*. The only other work done on this portion of the harbor during the year was replacing some decking that had been torn from the west pile pier during a severe gale, May 18–22, 1894, and restoring some filling that was washed out at the same time.

The condition of the harbor at the close of the year was as follows: The old west pier, 2,157 feet long, is in fair condition, but considerable repairs will be required in the near future to keep it so. A length of about 800 feet, entirely within the shore line, has long been occupied anp controlled by the Rawson & Root Lumber Company, and shows signs of failing at different points; but this portion should hereafter be classed with the rest of the interior harbor, and the mantenance of a proper channel revetment exacted from the riparian owner or occupant, and the Government should be at no further expense for its maintenance. The principal need of the out ersection, about 1,200 feet long, is a general refilling, with suitable provision made for retaining the new filling in the work. The old east pier is thoroughly decayed above water, and about 125 feet of its outer end is some feet below the water surface. This portion, as well as a further length of about 700 feet, must be restored, so as to put the pier in substantial repair as far back as the life-saving station and Government building; inside of that point it is not proposed to make repairs, as the maintenance of a suitable revetment properly devolves upon occupants or owners of the contiguous property.

The dredging done during the year has restored the inner channel to a good navigable condition, with a depth of 17 feet at entrance and a general depth of 13 feet above. The estimate for this portion of the harbor for 1896 is as follows: For repairing 850 feet of old east pier,

$8,500; for filling outer section of west pier, and minor repairs to the same, $5,000; for dredging to extend interior channel and maintain navigation in lower section, $5,000; making, with contingencies, $20,000.

Amount appropriated and expended from 1836 to 1869, inclusive	$287, 388. 92
Original estimated cost of project for inner harbor, 1870, revised in 1892.	131, 375. 00
Whole amount appropriated, 1870 to and including act of July 13, 1892.	124, 375. 00
Whole amounted expended to June 30, 1894	118, 862. 46

Money statement.

July 1, 1893, balance unexpended	$8, 956. 02
June 30, 1894, amount expended during fiscal year	3, 443. 48
July 1, 1894, balance unexpended	5, 512. 54
July 1, 1894, outstanding liabilities	1, 066. 32
July 1, 1894, balance available	4, 446. 22
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	20, 000. 00

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2. *Outer Harbor.*—This part of the improvement comprises work done in the execution of projects prepared in 1870 and 1882; the former providing for an outer basin located to the east of the entrance to the inner harbor, and the latter for works exterior thereto, whose purpose was to give increased safety for vessels entering during heavy weather, and provide a sheltered outside anchorage where vessels near this portion of Lake Michigan might find refuge against all northerly gales. The basin was completed in 1885, the structures then finished being as follows: (1) A pile pier 1,225 feet long extending in a northerly direction from the shore, and closing the basin on the east; (2) a crib breakwater 30 feet wide extending westwardly from the lake end of the pile pier for a distance of 1,411 feet, and covering the basin on the north; (3) the "breakwater pier," a crib structure 30 feet wide extending northward from the west end of the crib breakwater for a distance of 355 feet, and designed, in connection with the "exterior breakwater," then about to be commenced, to lessen the dangers attendant upon attempts to enter the harbor when high seas prevail. A subsequent extension of 150 feet to this pier, making its total length 505 feet, brought work relating to the outer basin to the conditions existing at the beginning of the fiscal year and at present. Nothing was done during the year as respects these works except to overhaul and equalize stone filling in the breakwater pier, and replace some decking plank on the main breakwater. The area comprised in the basin is shoal, and can not be utilized for commercial purposes until dredged, an undertaking that may best be deferred until the exterior breakwater has been built. The only expenditure contemplated in the near future in connection with this portion of the work is such as is needed for keeping the breakwater and breakwater pier in repair, for which purpose a sum of at least $5,000 should be available.

The "exterior breakwater" when completed as proposed will have a length of 2,000 feet, commencing at a point 400 feet west of the lake end of the "breakwater pier," extending thence about west 20° south 1,000 feet, and thence south 25° west 1,000 feet, the interior angle at the intersection of the two equal arms being 135°. One-half of the easterly arm had been completed before June 30, 1893, and a contract had been entered into with the Wisconsin Dredge and Dock Company, approved January 25, 1893, for adding a length of 200 feet. The contractors did not commence crib construction until April 17, 1894, from which date to end of the year they have made slow progress. Crib No. 1, 1894 (100 by 30 by 22½ feet), was built and sunk on its pile foundation June 30 in good line and level. The foundation piles, 76 in number, were driven in water 24 to 27 feet deep, to a penetration of from 15 to 24 feet in the bed of the lake, and sawed off at grade 22½ feet below zero of gauge. The diver's examination of this work, before placing the crib, disclosed the fact that three of the piles were beyond the prescribed limits as to line, and 15 as to level, and the defects were remedied by placing three additional piles in true line and resawing those out of level, all having been too high in the beginning. Crib No. 2, 1894, same size as No. 1, was built to the fourteenth course at the close of the year. The work then remaining to be done, to complete the contract, was to add eight courses to Crib No. 2, drive and saw to grade the 76 piles required for its foundation, sink the crib in position, place a continuous superstructure over the two cribs, and build it back into the superstructure of the portion already in place; it will probably be completed during the present summer.

No lights have yet been established by the Light-House Establishment on any of the outlying works in this harbor, and it has therefore been necessary to keep pier lights throughout the year, as heretofore, as a guide for vessels entering, at the expense of appropriations for harbor improvement.

The construction of the combination of works that are designed to constitute the outer harbor has been in progress twenty-two years, and it is impossible for any considerable advantage to local commerce or increased safety to general commerce to be realized until all shall be completed. The importance of a harbor of refuge in this part of Lake Michigan is well recognized, and the completion of the proposed works will provide it. Some minor modifications of detail may be desirable to finish the harbor in the best possible shape, but their consideration is neither necessary nor desirable just now. A prompt completion of the work already projected is the important present consideration, and, being satisfied that the essential features of a most excellent harbor for commerce and refuge will thereby result, it is respectfully urged that the next appropriation should supply the means for putting it all under contract. To this end, the appropriation should be $215,000, to be applied as follows: For constructing 1,300 feet of crib work to complete exterior breakwater, $195,000; for repairs of work already built, and engineering superintendence and contingencies, $20,000. By this policy the work can easily be completed within the limits of estimated cost, and the object sought secured in the near future. On the other hand, with small appropriations the cost will grow to figures far in excess of estimate, and the time when commerce can find safe refuge in this section be indefinitely postponed. Two vessels were wrecked—one a total loss—during the past winter and spring that in all probability would have found safety if the improvement had been completed.

The Light-House Establishment maintains a coast light on the main shore, and there is a life-saving station at the shore line east of the harbor entrance.

The harbor is in the collection district of Chicago, Ill. Nearest port of entry, Chicago, Ill.

Appropriations for improving harbor at Michigan City, Ind.

Date.	Outer Harbor.	Inner Harbor.	Total.
July 4, 1836			$20,000.00
March 3, 1837			30,000.00
July 7, 1838			60,733.59
June 11, 1844			25,000.00
*August 30, 1852			20,000.00
March 2, 1855 (claim J. R. Bowes)			470.33
June 23, 1866			75,000.00
July 25, 1868 (allotment)			25,000.00
April 10, 1869 (allotment)			31,185.00
July 11, 1870	$25,000.00		25,000.00
March 3, 1871	15,000.00		15,000.00
June 10, 1872	50,000.00		50,000.00
March 3, 1873	50,000.00		50,000.00
June 23, 1874	50,000.00		50,000.00
March 3, 1875	50,000.00		50,000.00
August 14, 1876	35,000.00		35,000.00
June 18, 1878	50,000.00	$25,000.00	75,000.00
1878 (allotment)	2,500.00		2,500.00
March 3, 1879	40,000.00		40,000.00
June 14, 1880	40,000.00	15,000.00	55,000.00
March 3, 1881	20,000.00	25,000.00	45,000.00
August 2, 1882	60,000.00	20,000.00	80,000.00
July 5, 1884	40,000.00	10,000.00	50,000.00
August 5, 1886	54,375.00	1,875.00	56,250.00
August 11, 1888	90,000.00	5,000.00	95,000.00
September 19, 1890	50,000.00	7,500.00	57,500.00
July 13, 1892	30,000.00	15,000.00	45,000.00
Total	751,875.00	124,875.00	1,163,638.92

* Amount carried to surplus fund, $5.15.

Original estimated cost of project for Outer Harbor, 1870	$324,421.40
Increase by cost of repairs and maintenance to 1882	90,067.10
Project for outer breakwater, including dredging of outer basin, 1882	587,000.00
Total estimate	1,000,488.50
Whole amount appropriated and allotted, 1870, to and including act of July 13, 1892	751,875.00
Whole amount expended to June 30, 1894	718,029.31

Money statement.

July 1, 1893, balance unexpended		$38,455.64
June 30, 1894, amount expended during fiscal year		4,609.95
July 1, 1894, balance unexpended		33,845.69
July 1, 1894, outstanding liabilities	$10,508.65	
July 1, 1894, amount covered by uncompleted contracts	14,563.73	
		25,072.38
July 1, 1894, balance available		8,773.31

Amount (estimated) required for completion of existing project	249,613.50
Amount that can be profitably expended in fiscal year ending June 30, 1896	215,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, MICHIGAN CITY HARBOR, INDIANA.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1885	1,334	$116.35	....
1886	966	90.10	....
1887	1,099	....	213,685
1888	1,167	....	213,074
Calendar year—			
1888	1,153	....	208,617
1889	795	....	169,193
1890	921	....	172,817
1891	837	....	168,654
1892	1,391	....	443,055
1893	1,577	....	589,863

Receipts by vessel, 1893.

[Compiled from statements furnished by the collector of customs and Capt. Manning, Michigan City, Ind.]

Articles.	Quantity.	Tons.
Cedar posts ... number	47,000	940
Coal	....	1,500
Fruit, miscellaneous ... packages	2,005	30
Gravel ... cubic yards	50	65
Laths ... M	7,300	2,190
Lumber ... feet, B. M	45,185	79,074
Potatoes ... bushels	6,650	200
Salt ... barrels	114,623	16,047
Shingles ... M	19,524	2,440
Slabs ... cords	401	1,070
Tan bark ... do	75	75
Ties ... number	30,875	2,779
Wood ... cords	476	714
Total	....	107,124

NOTE.—No record is kept at Michigan City of traffic between this port and Chicago.

L L 2.

IMPROVEMENT OF ST. JOSEPH HARBOR, MICHIGAN.

The improvement of this harbor by the Government was commenced as far back as 1836, and $192,613 has been applied thereto up to 1867. Before improvement, entrance to St. Joseph River was by a shifting channel with depths fluctuating between 3 and 7 feet.

The present project of improvement looks to providing a channel 16 feet deep from Lake Michigan to the upper limits of St. Joseph Harbor, and an interior navigation with a depth of 13 feet from there to Benton Harbor, nearly 1 mile above. The projected depth at entrance has not yet been obtained and probably will not be without considerable extension of the present piers. The interior depth of 13 feet is fairly well kept up by frequent dredging. The general conditions are well stated in the following extract from the last Annual Report:

> The St. Joseph River is subject to floods in the spring, bringing down large amounts of sand and mud and filling up the channels. The harbor, including the waterway to Benton Harbor, at the head of the canal, has an extensive commerce by land and water, three railways and numerous steamers bringing traffic to the port, and it is a matter of importance to maintain and improve the relatively limited facilities which the navigation conditions afford. The extension of the piers is indispensable

to the protection and betterment of the entrance, and large amounts of dredging are needed to widen and deepen the interior channels.

* * * * * * *

Extensive shoals have moved north of the entrance, which have lapped over the pier and at times threaten to close the entrance, and as dredging in the open lake is impracticable, except when the water is quiet, there is no remedy other than to extend the pier.

* * * * * * *

With reference to the inner navigation, no special difficulties are met other than the need of frequent dredging.

The discharge of the Paw Paw River directly into the canal is a marked disadvantage, as incessant shoaling occurs in that vicinity. It would be a simple matter, as well as a radical cure of the difficulty, to open a discharge for the Paw Paw through the low marsh directly into the head of the harbor, back of the so-called "wing dam," and close the present mouth of the canal entirely.

The condition of the harbor at the beginning of the year was as follows:

The north pier—comprising 831½ feet of pile work and 831 feet of crib work—had a total length of 1,662½ feet, and projected 635 feet beyond the shore line.

The south pier—comprising 606 feet of pile work and 213 feet of crib work—had a total length of 819 feet, of which 550 feet was beyond the shore line.

The depth of water on the bar at entrance was 15 feet and that of the interior navigation 13 feet, except near the lower end of the "wing dam," where there was an extensive shoal, over which the depth was reduced to 11½ feet.

Work was in progress for extending the north pier 350 feet under contract with E. G. Crosby, of Muskegon, Mich., approved February 4, 1893; Crib No. 1 (50 by 30 by 18½ feet) had been built ready for sinking; cribs No. 2, No. 3, and No. 4 (each 100 by 30 by 18½ feet) had been built to the 13th, 9th, and 5th courses, respectively, and the 36 foundation piles for Crib No. 1 had been driven.

Operations during the past year in continuation of the above work, for repairs and dredging, were as follows:

The construction of cribs Nos. 1, 2, and 3 was completed, 218 piles driven for their foundations, and, with those previously driven for Crib No. 1, sawed off to grade 18 feet below water surface at zero of gauge. The piles were driven in water from 19.2 to 21.5 feet deep, and penetrated from 13½ to 17½ feet into the bed of the lake. The four cribs were successively sunk to a good bearing on their pile foundations July 7, July 29, August 15, and August 31. A continuous superstructure six courses high was built over the new cribs, bonded back into superstructure of older work, filled with stone, and decked over; mooring posts were secured in the work at intervals of 50 feet, and pierhead protection made by driving a row of close piling between the end horns, with three facing wales above water, screw-bolted to end wall of crib. The whole was completed October 12, making an actual extension of 350.8 feet.

The steam barge *Ida E* left the harbor during a heavy gale October 6, was compelled to return, and, in attempting the entrance, collided with the north pier near the shore line and caused such damage that the sea was enabled to make a complete breach through the work into the harbor, carrying with it large quantities of sand. The breach extended from station 4+50 to 6+30, a distance of 180 feet, and for a further distance of 120 feet the waling piece, through which the tie-rods passed, was torn away. The break was repaired by driving rows of close piling just outside of the old cribwork, capping them with two courses of superstructure connected by timber ties, and placing wales and connecting tie-rods at the water surface; vertical sheet piling of 6 by 12 inch timbers was driven along the rear of channel row of piles, horizontal backing timbers 6 by 12 inches placed on the lake-side row, and the structure filled with stone. Broken timbers adjoining the break were taken out and new ones put in their place. Cold and stormy weather prevailed while these repairs were in progress, delaying their completion until December 9. Minor repairs were made at other parts of the work, such as replacing broken or decayed timbers, and a row of sheet piling placed in the pile wing at inner end of the north revetment, extending from the light-house wharf to the boat opening at the life saving station, a distance of 250 feet.

The United States dredge *Michigan City* was at work on the wing-dam shoal from October 5 to November 20, where the navigable depth was only 10½ feet when work was commenced; a channel 50 feet wide was cut to the depth of 18 feet through the worst part of the shoal, the amount excavated being 17,935 cubic yards.

Work done during the year by private parties at this harbor, by authority of the Secretary of War and under the supervision of the U. S. engineer, was as follows:

(1) By E. A. Graham: Rebuilding his dock below the railroad bridge, about 745 feet long, authorized by the acting Secretary of War February 23, 1893.

(2) By John Wallace: Rebuilding his dock (Vandalia Dock) from a point about 200 feet above the railroad bridge and extending eastwardly for a distance of 507.4 feet; instrument of authority dated May 25, 1893.

(3) By the Cincinnati, Cleveland, Chicago and St. Louis (Big Four) Railway Company: Rebuilding east 300 feet of wing dam, provided in the river and harbor act of July 13, 1892, authorizing its occupation by the company for freight purposes.

Also by this company: Rebuilding old revetment on the north side of entrance to Benton Harbor Canal, from railroad warehouse to mouth of Paw Paw River, a distance of 520 feet; instrument of authority dated March 30, 1894.

All the foregoing structures have been satisfactorily completed as authorized.

(4) By J. A. Preston: Construction of new wharf in front of his property, extending from mouth of Morrisons Channel to wharf at mouth of the St. Joseph River, a frontage of about 1,475 feet. The wharf is to be built to conform to a harbor line recommended for adoption in a report by the United States engineer dated June 1, 1894, and approved by the Secretary of War June 8, 1894. The formal instrument of authority to build the wharf is dated June 19, 1894.

The work of construction was in progress at the close of the year.

A resurvey of the harbor, from its entrance to the upper limit of interior navigation at Benton Harbor, was made June 11-16, 1894, and blue-print copy of the map will be forwarded when completed. It shows a narrow entrance channel with a depth of scant 15 feet, and an interior navigable depth of from 13 to 14 feet except at crossing of the wing-dam shoal where scant 12 feet only is available.

The condition of the piers June 30, 1894, was as follows:

North pier and revetment, comprising 831.5 feet of pile work and 1,182 feet of crib work, had a total length of 2,013.5 feet, and projected about 1,300 feet beyond the shore line; this is more than double the projection of a year ago, and is made up by 300 feet of pier extension, and a back cutting of the fore shore resulting from the breach made, in the pier last October and a subsequent washing out of all adjoining pier filling, to about 4 feet below the water line, during a severe gale May 18, 1894. The sand thereby washed into the harbor would have closed it to navigation if an unusual outflowing current had not prevailed at the same time, due to the full rivers above. The pier is really unserviceable along this section, and its complete reconstruction is urgently needed for a length of 375 feet. The pile structure inside of this section lacks filling and is open to the passage of sand into the harbor; it should be sheet piled and refilled. The outlying 800 feet of crib work is in good condition, or can be easily made so by distributing a small amount of stone to supply deficiencies in filling.

The south pier is practically the same as it was at the commencement of the year—819 feet long and projecting 550 feet beyond the shore line. The filling of pile work has gone at almost all points to below the water level, and its restoration is essential to secure the work; otherwise this pier is in fair repair.

The estimate for 1896 is as follows: For 850 feet of crib-pier extension, $85,000; for rebuilding 375 feet of old north pier, $7,500; for sheet piling and refilling 550 feet of pile work in north pier, $5,500; for refilling 600 feet of south pile pier, $3,000; dredging and minor repairs, $5,000; total, with contingencies, $115,000.

The Light-House Establishment maintains a fourth order revolving coast light on the bluff south of the harbor, and a fifth order harbor light and a range light on the north pier; there is a life-saving station near the east end of north pier.

The harbor is in the Michigan collection district, Michigan; port of entry, Grand Haven, Mich.

Appropriations for improving St. Joseph Harbor and River, Michigan.

July 4, 1836		$20,000
March 3, 1837		15,000
July 7, 1838		51,113
March 3, 1843		25,000
June 11, 1844		20,000
* August 30, 1852		10,000
June 28, 1864		15,000
June 23, 1866		6,000
March 2, 1867		23,000
Allotted from harbors on Northwestern Lakes, 1867	$7,500	
Transferred in 1870 to Grand Haven Harbor..	500	
		7,000
July 11, 1870		15,000
March 3, 1871		10,000
June 10, 1872		$3,000
June 23, 1874		2,000
March 3, 1875		35,000
August 14, 1876		12,000
June 18, 1878		12,000
March 3, 1879		6,000
June 14, 1880		8,000
March 3, 1881		10,000
August 2, 1882		12,000
July 5, 1884		15,000
August 5, 1886		10,000
August 11, 1888		12,000
September 19, 1890		20,000
July 13, 1892		60,000
Total		434,113

Original estimated cost of the work as revised in 1892	$519,113.00
Whole amount appropriated from 1836 to and including act of July 13, 1892	434,113.00
Whole amount expended to June 30, 1894	432,814.02

Money statement.

July 1, 1893, balance unexpended	$48,588.91
June 30, 1894, amount expended during fiscal year	48,290.73
July 1, 1894, balance unexpended	298.18
July 1, 1894 outstanding liabilities	109.97
July 1, 1894, balance available	188.21
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	115,000.00

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* Amount carried to surplus fund, $0.80.

COMMERCIAL STATISTICS, ST. JOSEPH AND BENTON HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	560	$1,096.14	....
1885	467	361.57	....
1886	789	248.53	....
1887	580	....	144,000
1888	679	....	208,797
Calendar year 1889	966	....	359,925

Year.	Vessels entered.		Vessels cleared.	
	Number.	Tonnage.	Number.	Tonnage.
1890 (including Benton Harbor)	948	131,607	946	131,395
1891 (including Benton Harbor)	742	215,334	743	215,591
1892 (including Benton Harbor)	1,726	707,285	1,727	707,785
1893 (including Benton Harbor)	1,576	1,125,063	1,575	1,125,938

The Graham & Morton Transportation Company established a regular line of steamers between this port and Milwaukee, Wis., to succeed to the business of the St. Joseph and Lake Michigan Transportation Company and the Milwaukee and Eastern Transportation Company. The Flint and Pere Marquette Steamship Line has made two or three trips per week to this port during the season, bringing large quantities of salt from Manistee, Mich. The equipment of the lines heretofore operated to Chicago has been increased.

Receipts and shipments by vessel at St. Joseph and Benton Harbor, Michigan, 1893.

[Compiled from statements furnished by the Graham & Morton Transportation Company of St. Joseph, Mich., and the collectors of customs at St. Joseph and Benton Harbor, Michigan.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Cedar posts ......number..	15,000	150	Apples and pears, barrels.	30,000	3,500
Flour ....barrels..	40,600	4,060	Farm products, miscellaneous	....	1,000
Fruit, miscellaneous, packages..........................	13,180	198	Fish	....	800
Grain ....bushels..	111,640	2,820	Flour ....barrels..	11,962	1,195
Gravel....... cubic yards..	500	750	Fruit, miscellaneous, packages.	1,138,436	20,077
Hay and feed....................	....	1,503	Grapes ....baskets..	700,000	3,500
Iron and ore....................	....	1,700	Hay and feed..................	....	18
Laths	25,000	10,000	Iron and ore	....	2,000
Leather	....	75	Lime and cement, barrels..	2,000	400
Lime and cement..barrels..	1,000	300	Live stock...........head..	209	74
Live stock............head..	119	45	Lumber........ feet, B. M..	128,000	224
Lumber..... M feet, B. M..	33,553	64,968	Machinery	....	300
Machinery	....	200	Merchandise, general......	....	777
Merchandise, general.	....	2,800	Miscellaneous..................	....	8,504
Miscellaneous..................	....	14,732	Paper	....	1,070
Salt ....barrels..	400,500	56,070	Peaches ....baskets..	400,000	4,000
Shingles........................	75,000	16,000	Potatoes........ bushels..	50,000	1,600
Slabs ....cords..	800	2,000	Total..................	....	44,039
Stone ....do...	1,500	9,500			
Total..................	....	187,371			

In addition to the above, a total of 189,275 passengers were carried by vessels trading at this port.

L L 3.

IMPROVEMENT OF ST. JOSEPH RIVER, MICHIGAN.

The only portion of the river used for commercial purposes in recent years is the lower stretch of about 25 miles, from its mouth at St. Joseph to Berrien Springs. Throughout this section it is very crooked, the land distance between extremities being but little more than half the distance by river. It is obstructed by a number of shoals and ripples, over which the water flows in a thin sheet, with channel depths of approximately 2 feet, while the general depth in intervening pools will run from 4½ to 6 feet, or even to 7 or 8 feet in some of them.

The river and harbor act of August 11, 1888, appropriated $2,500 for improving the river within the limits above indicated, and a project for its expenditure with a view to obtaining a low-water channel of 3 feet was approved March 27, 1889. The plan of operations provided for removing snags and sunken logs, closing secondary channels by brush and stone dams, and concentrating the flow at other points, as found necessary, by wing dams. The plan has been followed as far as could be with the small sums appropriated for the work, and has provided the anticipated depth of 3 feet at the improved places; but other shoal places remain, and the structures already erected, having necessarily been of a light and inexpensive character, are in need of additions and repairs.

Operations during the past fiscal year were as stated in the following extract from the report of F. W. Lehnartz, assistant engineer, in local charge of works in that portion of this district:

> The dam closing the south arm of the river at Twin Springs Island had been damaged by the spring freshets and a new channel had been scoured by the river near the head of the island. This new division of the river's volume reduced the effective current in the main channel, and navigation was practically closed at this point. New shoals had also formed on Long Reach, and in July operations to improve these conditions were commenced. The closing dam at Twin Springs Island was repaired by the addition of brush and stone, and extended 235 feet to a point on the island which seemed to offer special resistance to erosion by the river. The old training dike at foot of Twin Springs Island was repaired.
>
> Dam Nos. 1, 6, and 9, on Long Reach, were repaired and made more effective by raising them about 1 foot, and a new dam, No. 13, 150 feet long, was built between Nos. 6 and 9. In addition, two new dams, Nos. 14 and 15, each 150 feet long, and resting against the north shore, were constructed to further restrict the low-water width of the river.
>
> As the main channel at Royalton Island showed a tendency to shoal, the south arm was closed by a dam, throwing all the water into the main channel. These operations were completed September 30, 1893.

The maintenance of this navigation requires further dam construction, repair of existing structures, and the removal of snags and logs. For these purposes an appropriation of $2,500 is needed.

Appropriations for improving St. Joseph River, Michigan.

August 11, 1888	$2,500.00
September 19, 1890	1,000.00
Total	3,500.00
Whole amount appropriated, including allotment from appropriation for St. Joseph Harbor by act of July 13, 1892	4,500.00
Whole amount expended to June 30, 1894	4,129.24

Money statement.

July 1, 1893, balance unexpended	$1,049.73
June 30, 1894, amount expended during fiscal year	678.97
July 1, 1894, balance unexpended	370.76
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	2,500.00

COMMERCIAL STATISTICS, ST. JOSEPH RIVER, MICHIGAN, 1893.

The steamer *May Graham* (95 tons, load draft 30 inches) made 100 trips from St. Joseph to Berrien Springs and return, carrying 10,000 passengers and 6,234 tons of miscellaneous freight.

L L 4.

IMPROVEMENT OF SOUTH HAVEN HARBOR, MICHIGAN.

Before improvement by the General Government the citizens of South Haven had constructed piers and revetments at the mouth of the Black River, and thereby obtained a channel into Lake Michigan 6 or 7 feet deep and 85 feet wide; the improvement thus started was taken up by the Government in 1867, under a plan of operations that provided for increasing the channel to a width of 120 feet between piers extended far enough into Lake Michigan to obtain and hold a navigable depth of 12 feet; the original project was subsequently modified to make the entrance width between piers 177 feet, and extend the navigable channel upstream to the highway bridge, about half a mile above the piers. The total length of piers and revetments built, up to the year 1888, aggregated 3,145 feet, and no extensions have been made to them since that time.

Operations during the past fiscal year were as stated in the following extract from report made F. W. Lehnartz, assistant engineer, in local charge of harbors on the eastern shore of Lake Michigan:

> The rebuilding above water of the old crib work in the south pier, station 9+98 to 13+54½, commenced in May, 1893, was completed September 19. The remainder of the old timber work above water, station 11+95 to 9+98, was removed, as also the stone filling and the 6 courses of new superstructures completed to station 9+98. The old stone filling was replaced in the work, mooring posts were built into it at distances of 50 feet, and a walk 3 feet wide placed along each side wall. The old work between stations 8+70 and 9+98, and between stations 13+54½ and 14+02 was repaired, and the decayed top timber of the channel wall, south pier, stations 13+88 to 14+47, replaced by new timber.
>
> Soundings made July 29-31, 1893, showed the existence of a shoal with only 11 feet water in the river channel near the winding basin, a narrow channel with 12 feet water thence to the revetments of the entrance, 11.5 feet between piers and revetments and 11.8 feet on the bar. To improve this condition the United States dredge *Michigan City* commenced dredging July 31, and by October 2, when it was completed, had removed the shoal near the winding basin by dredging an area 75 feet wide, about 150 feet long, and 15 feet deep below zero of gauge, had widened the river channel from station 14 to the revetments by a cut 50 feet wide and 15 feet deep, and the channel between the revetments by a cut 25 feet wide and 15 feet deep, from the inner end to station 7, and had deepened and widened the channel between the piers by a cut 50 feet wide and 17 feet deep from station 10 to 15+50. The total quantity of sand and clay removed from these cuts was 23,865 cubic yards. During the time from September 2 to September 20 the dredge was absent from the harbor, having been sent to Saugatuck for needed dredging at that point.

At the opening of navigation in 1894 the channel at the entrance was again found filled up, as usual. Soundings of April 13–14 showed an available depth of 10 feet on the outlying bar and 10 feet between the piers to shore line; thence generally 13 feet to the steamboat landing. The United States dredge *Farquhar*, after fitting out at Grand Haven, was at once dispatched to South Haven, arriving there April 21. The channel across the bar was again dredged out to a width of 75 feet and depth of 17 feet, the channel between piers by a cut 25 feet wide and 15 feet deep from station 8 to 15+30, and by a second adjacent cut of the same dimensions from station 8 to 12, and a shoal below the highway bridge, station 24+70 to 25+30, immediately in front of the steamboat landing, was removed. This work was completed on May 14, leaving a through-going channel width not less than 12 feet water, and the dredge was sent to Holland Harbor. The material dredged at this time measured 7,893 cubic yards.

During the storm of October 6 the portion of the south revetment from station 4+77 to 6+22, a plank-beam structure, caved into the channel and was washed away. The lateness of the season prevented repairs, but to prevent the break from enlarging until more permanent repairs can be made, the remaining work was strengthened by driving two piles at each end, one in front and the other well in the rear, and tying them together with chain.

The condition of the harbor works at the date of this report is as follows:

North pier.—Comprising 606 feet of crib work, 524 feet pile pier and revetment, and 462 feet sheet pile revetment—has a total length of 1,592 feet and projects 730 feet beyond the shore line. The section of pile pier and revetment is badly dilapidated and needs rebuilding above water. More than one-half of the old crib work was built from twenty-four to twenty-six years ago, and must also be rebuilt above water; considerable addition to filling is required to put the pier in a safe and serviceable condition.

The south pier, comprising 555 feet crib work, 143 feet pile revetment, and 855 feet plank-beam revetment, has a total length of 1,553 feet, and projects 510 feet beyond the shore line. The plank-beam revetment is badly wrecked in parts, the remainder liable to give way at any time, and all should be rebuilt; but it is believed that appropriations for the improvement of this harbor should no longer be charged with the expense of maintaining this interior revetment, as the adjoining property is mostly occupied and used for commercial purposes by private parties and corporations.

The depth of water requisite for navigation at this harbor cannot be maintained until the piers are extended to the 15-foot curve in Lake Michigan; additions of 250 feet and 450 feet must be made to the north and south piers, respectively, to accomplish this, and the present project provides for extensions aggregating half that amount. The interior navigation can only be maintained by constant dredging, the river being narrow and the north bank without revetment.

The estimate for 1896 is as follows: For extending north pier 150 feet and south pier 200 feet, under existing project, $42,000; rebuilding above water 875 feet north pier and refilling same, $8,750; refilling piers and minor general repairs, $2,500; dredging, $4,000, making, with contingencies, $62,000.

Appropriations for improving harbor at South Haven, Mich.

March 2, 1867	$43,000
July 11, 1870	10,000
March 3, 1871	15,000
June 10, 1872	12,000
March 3, 1873	20,000
June 23, 1874	10,000
March 3, 1875	10,000
August 14, 1876	10,000
June 18, 1878	12,000
March 3, 1879	7,500
June 14, 1880	$5,000
March 31, 1881	5,000
August 2, 1882	10,000
July 5, 1884	7,500
August 5, 1886	5,000
August 11, 1888	10,000
September 19, 1890	15,000
July 13, 1892	10,000
Total	217,000

Original estimated cost of the work, 1866, amended in 1869, 1872, and 1892	$262,000.00
Whole amount appropriated from 1866 to and including act of July 13, 1892	217,000.00
Whole amount expended to June 30, 1894	215,731.06

Money statement.

July 1, 1893, balance unexpended	$6,564.68
June 30, 1894, amount expended during fiscal year	6,295.74
July 1, 1894, balance unexpended	268.94
July 1, 1894, outstanding liabilities	12.50
July 1, 1894, balance available	256.44
Amount that can be profitably expended in fiscal year ending June 30, 1896	62,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, SOUTH HAVEN HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	466	$555.72	
1885	361	204.50	
1886	283	113.55	
1887	264		52,800
1888	420		29,134
Calendar year—			
1889 (estimated)	1,080		
1890	2,246		128,880
1891	2,994		201,380
1892	3,060		212,160
1893	3,822		251,730

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by C. J. Monroe, esq., South Haven, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Brick		875	Apples and pears . barrels	3,070	307
Cedar posts . . . number	3,500	70	Berries . . . crates	6,000	750
Coal		200	Brick . . . number	85,000	213
Grain		859	Farm products		488
Gravel . . . cubic yards	445	579	Fish		17
Hay and feed		360	Flour . . . barrels	980	98
Lath . . . number	863,000	259	Leather		160
Lime and cement . . barrels	1,200	156	Live stock		213
Lumber . . . feet, B. M.	7,353,000	12,868	Lumber		2,506
Machinery		200	Merchandise, general		330
Merchandise, general		2,805	Peaches and grapes, baskets	1,178,060	7,068
Rawhides		252	Pickles . . . barrels	500	63
Salt . . . barrels	2,223	311	Potatoes . . . bushels	3,440	103
Shingles . . . number	4,287,000	536	Slabs . . . cords	560	1,505
Stone		275			
Tan bark . . . cords	260	260			
Tan-bark extract . . barrels	700	140	Total		13,821
Total		20,505			

L L 5.

IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

This harbor is at the mouth of the Kalamazoo River, where the channel depth before improvement was generally not over 5 feet. Its condition was first improved by a private company which built two slab piers for confining the river current, and thereby obtained a channel depth of 7 feet temporarily. Its further improvement was commenced by the General Government in 1869, and from that time to 1882 the piers were extended and interior channel revetments constructed until they had a total length of 1,907 feet on the north, and 3,863 on the south side, all of pile work. Since 1882, appropriations having been too small to keep these structures in repair, they have gradually gone to decay. The navigable channels opened through the harbor from time to time by dredging, fill up again very soon after the departure of the dredge.

This harbor is the natural outlet for the products of a highly cultivated section of country and would be the scene of active commerce if improved so as to afford any reliable navigation. The approved project called for a 12-foot navigation, but the existing works are wholly unequal to providing it or anything approximating it; the lake end of the piers are not beyond the curve of 4-foot depth in Lake Michigan, and the structures are simply wrecks in their present condition.

Operations during the past fiscal year were as follows: At the beginning of the year the United States dredge *Michigan City* was at work dredging a channel at the outer bar and the worst shoals inside; the work was continued to July 28, when the total excavation of 23,881 cubic yards was completed, resulting in a narrow channel from 10 to 12 feet deep where depths of from 5 to 6 feet had existed at the commencement of operations. About 11,000 yards of the amount above reported was excavated between June 13 and 30, 1893. The entrance channel lasted but a short time, and the dredge was again sent there September 2 to reopen it and dredge an interior shoal that had developed opposite the light-house. Work was continued, with considerable delays on account of stormy weather, until September 18, when the money available was nearly exhausted, and operations were suspended after excavating 4,825 cubic yards, resulting in a narrow 13-foot channel through the worst part of the outer bar and one 10 feet deep through the interior shoal. Survey of the harbor made June 6–9, 1894, showed depths of only 5 to 7 feet on the several bars and shoals, but there were no sufficient funds available for effective work, and the result is that the harbor is now practically closed to navigation.

The present condition of the harbor works is as follows: The north pier, with a total length of 715 feet of pile work, projects 200 feet beyond the shore line; its filling is all gone and the sea has an uninterrupted sweep through the work. The south pier has a total length of 3,863 feet of piling and projects 210 feet beyond the present shore line; from its outer end, for a distance of 2,525 feet, this pier is a total wreck and can only be preserved for further use by rebuilding it above water and refilling it. Further inside the timber work is in fair repair, but the filling is nearly all gone.

If there be any intention to maintain this as a navigable harbor, a general reconstruction of existing structures is necessary. If an establishment of a navigable depth of 12 feet, as heretofore contemplated, is to be accomplished, the old works must be put in serviceable condition, as above indicated, and both piers extended to the curve of 15-foot depth in Lake Michigan, now distant 1,000 feet and 800 feet from the north and south pier ends, respectively. No estimate for the above work is submitted for the reason that there is no present authority for undertaking it, and the estimate below is therefore confined to that needed for dredging to open temporary channels at times when they are most needed, and for such repairs as are requisite to save the existing works from total destruction.

The estimate for 1896 is, therefore, as follows: For rebuilding 2,800 feet of north and south piers above water and refilling same, $28,000; for dredging, $5,000; making, with contingencies, $35,000.

The Light House Establishment maintains a fifth-order light on the north side of the entrance.

The harbor is included in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Appropriations for improving harbor at Saugatuck, Mich.

July 25, 1868	$23,900	March 3, 1879	$5,000
April 10, 1869	6,039	June 14, 1880	5,000
July 11, 1870	10,000	March 3, 1881	5,000
March 3, 1871	10,000	August 2, 1882	8,000
June 10, 1872	15,000	July 5, 1884	4,000
March 3, 1873	10,000	August 5, 1886	8,000
June 23, 1874	10,000	August 11, 1888	5,000
March 3, 1875	10,000	July 13, 1892	5,000
August 14, 1876	3,000		
June 18, 1878	2,500	Total	145,439

Original estimated cost of the work, 1867, modified in 1869, 1870, 1875, and 1882	$175,699.46
Whole amount appropriated from 1868 to and including act of July 13, 1892	145,439.00
Whole amount expended to June 30, 1894	145,430.15

Money statement.

July 1, 1893, balance unexpended	$2,268.02
June 30, 1894, amount expended during fiscal year	2,259.17
July 1, 1894, balance unexpended	8.85
July 1, 1894, outstanding liabilities	8.13
July 1, 1894, balance available	.72
Amount (estimated) required for completion of existing project	30,260.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, SAUGATUCK HARBOR, MICHIGAN.

Entrances and clearances.

Years.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	300	$422.84	....
1885	265	118.86	....
1886*	....	....	....
1887*	....	....	....
Calendar year—			
1888	662	....	132,400
1889	314	....	76,380
1890	178	....	42,000
1891	492	....	120,000
1892*	....	....	....
1893	626	....	163,632

* Not stated.

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by Griffin & Henry, Saugatuck, Mich.]

Articles.	Quantity.	Tons.
RECEIVED.		
Baskets, number	2,000,000	1,000
Coal, iron ore, and machinery		2,960
Lime and cement, barrels	700	96
Lumber		2,750
Merchandise, general		700
Total		7,506
SHIPPED.		
Apples and pears, barrels	314	31
Carcasses, veal, number	600	97
Fish		113
Fruit, miscellaneous, packages	19,682	295
Furniture		10
Live stock, heads	20	3
Peaches, baskets	1,508,875	37,722
Potatoes, bushels	1,292	44
Poultry and lambs, coops	377	19
Total		38,334

REPORT OF COST OF COMPLETING IMPROVEMENT OF SAUGATUCK HARBOR, MICHIGAN.

[Printed as House Ex. Doc. No. 261, Fifty-third Congress, second session.]

WAR DEPARTMENT,
Washington, D. C., August 10, 1894.

SIR: I have the honor to acknowledge the receipt of a resolution of the House of Representatives, dated July 18, 1894, concurred in by the Senate on July 26, 1894, requesting the Secretary of War—

> to furnish the House with an estimate of the probable cost of completing the improvement of Saugatuck Harbor, Michigan, under the project of eighteen hundred and sixty-seven, as modified in eighteen hundred and sixty-nine, eighteen hundred and seventy, eighteen hundred and seventy-five, eighteen hundred and eighty-two, and the improvements recommended in the report of the Chief of Engineers for the year eighteen hundred and ninety-three, Apppendix M M,

and in response to the above resolution to transmit herewith a letter from the Acting Chief of Engineers, dated the 8th instant, submitting the accompaying copy of a report, dated the 4th instant, from Lieut. Col. G. J. Lydecker, Corps of Engineers, the officer in charge of the improvement of the harbor in question.

Colonel Lydecker estimates the cost of the improvement proposed at $260,000, and states that the maintenance of the improvement would probably call for annual dredging at an estimated cost of about $3,000.

Very respectfully,

JOSEPH B. DOE,
Assistant Secretary of War.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., August 8, 1894.

SIR: I have the honor to return herewith resolution of the House of Representatives of July 18, 1894, concurred in by the Senate July 26, 1894, requesting the Secretary of War "to furnish the House with an estimate of the probable cost of completing the improvement of Saugatuck Harbor, Michigan, under the project of 1867, as modified in 1869, 1870, 1875, 1882, and the improvements recommended in the report of the Chief of Engineers for the year 1893, Appendix M M," and in answer to its reference to this office to submit the accompanying copy of report of the 4th instant on the subject from Lieut. Col. G. J. Lydecker, Corps of Engineers, the officer in charge of the improvement of the harbor in question.

Col. Lydecker submits an estimate amounting to $260,000 as the cost of the improvement proposed at Saugatuck under the call contained in the accompanying resolution.

The maintenance of the improvement would probably call for annual dredging at a cost of about $3,000.

Very respectfully, your obedient servant,

H. M. ADAMS,
Acting Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., August 4, 1894.

GENERAL: Complying with instructions of July 28, I submit the following report concerning the inquiry presented in the resolution adopted in the House of Representatives July 18, 1894, and agreed to by the Senate July 26, 1894, viz:

[Fifty-third Congress, second session, Congress of the United States.]

IN THE HOUSE OF REPRESENTATIVES, *July 18, 1894.*

Resolved by the House of Representatives (the Senate concurring), That the Secretary of War be requested to furnish the House with an estimate of the probable cost of completing the improvement of Saugatuck Harbor, Michigan, under project of eighteen hundred and sixty-seven as modified in eighteen hundred and sixty-nine, eighteen hundred and seventy, eighteen hundred and seventy-five, eighteen hundred and eighty-two, and the improvements recommended in the report of the Chief of Engineers for the year eighteen hundred and ninety-three, Appendix M M.

Attest:

JAMES KERR,
Clerk.

IN THE SENATE OF THE UNITED STATES, *July 26, 1894.*

Resolved, That the Senate agree to the foregoing resolution of the House of Representatives.

Attest:

WM. R. COX,
Secretary.

The resolution appears to contemplate two estimates:

(1) Estimate of the probable cost of completing the improvement of Saugatuck Harbor, Michigan, under the project of 1867, as modified in 1869, 1870, 1875, 1882.

(2) Estimate of cost of the "improvements recommended in the report of the Chief of Engineers for the year 1893, Appendix M M."

By the project of 1867 it was proposed to dredge a channel 200 feet wide and 12 feet deep from Lake Michigan into the mouth of the Kalamazoo River, and protect the channel between crib piers extending to the 12-foot curve in the lake, these piers to be in extension of about 2,000 linear feet of slab piers already built by local enterprise. The estimated cost was as follows: For 2,048 feet of crib piers, $158,446.90; for dredging, $44,848.90; total, $203,295.80. The modification of 1869 was recommended "as the best that can be done with the amount of money," and related mainly to improving the lower reach of the river by dredging, protecting the dredged channels by pile revetments, and building 192 linear feet of crib work in extension of the north slab pier; the project of 1870 simply related to so much of this work as was to be built on the north side of the channel. The estimated cost of the project of 1869–'70 was as follows: For 192 linear feet crib pier, $8,038.36; for 5,130 linear feet pile revetments, $63,175.20; for dredging, $15,185; total, $86,398.56.

The project of 1875 provided for restoration and preservation of revetments, built in accordance with the project of 1869–'70, at an estimated cost of $10,000.

The conclusion arrived at in 1882 was that future appropriations should be applied merely to maintaining the existing conditions of the improvements. This is not regarded as having modified previous projects, but simply as serving to suspend operations under them, and it is to be omitted from consideration in the estimate now submitted in response to the first part of the resolution, viz:

Estimate of the probable cost of completing the improvement of Saugatuck Harbor, Michigan, under the project of eighteen hundred and sixty-seven as modified in eighteen hundred and sixty-nine, eighteen hundred and seventy, eighteen hundred and seventy-five, and eighteen hundred and eighty-two, as follows:

Building 1,100 linear feet crib work, extending north pier to 12-foot curve	$82,500
Building 800 linear feet crib work, extending south pier to 12 foot curve	60,000
Refilling and sheet piling 715 feet old revetment on north side	3,575
Building 2,400 linear feet new revetment on north side	36,000
Building 500 linear feet new revetment on south side	7,500
Rebuilding above water 2,525 linear feet, south pier and revetment	20,200
Refilling 3,860 linear feet of old south side revetment	19,300
Total for piers and revetments	229,075
For dredging channel	15,000
	244,075

The maintenance of the improvement would probably call for annual dredging at a cost of about $3,000.

I do not find that there is any specific project of improvement recommended in the report of the Chief of Engineers for the year 1893, but assume that the inquiry contained in the resolution is directed to the following suggestion: "With these (the piers) extended, the south revetment refilled, and the influx of sand from above contracted, as is quite practicable by means of sand fences and shrub planting, the purpose of the original project can be carried out and a commercial harbor of considerable value made." The work herein suggested is practically the same as that covered by the foregoing estimate for completing the project of 1869, as subsequently amended, with the addition of sand fencing and shrub planting to prevent the inflow of sand from adjoining hills; the cost of these latter works may be estimated at about $15,000, making the total cost of completing the improvement, as suggested in the annual report for 1893, $260,000 in round numbers.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

L L 6.

IMPROVEMENT OF HOLLAND (BLACK LAKE) HARBOR, MICHIGAN.

The first steps toward establishing a harbor at this place were taken by the citizens of Holland, Mich., situated on Black Lake, about 5 miles from the present harbor, by opening a channel having a navigable depth of about 5 feet from the lake into Lake Michigan, and protecting it by piers and revetments made of brush and stone. Continuation of this improvement was taken in hand by the General Government in 1867, existing structures strengthened by pile and crib work, and extended until, in 1880, the north side pier and revetment had attained a total length of 1,850 feet and the south side 1,689 feet. They have remained without extension since that time. The approved project calls for a channel depth of 12 feet, but a depth of from only 8 to 9 feet can be maintained while the piers remain in their present condition, and increased depths are attained temporarily by repeated dredging. The piers are not only far too short to protect an entrance channel, but the interior portions built on the old brush structures permit the passage of large quantities of sand through and under them, for which reason any dredged channel soon becomes filled.

No work was done at the harbor during the last fiscal year until the middle of May, 1894, when the United States dredge *Farquhar* was sent there to restore the channel between piers, which was shown by soundings made in the latter part of April to have shoaled to 9 feet. The work was still in progress at the close of the year, up to which time 12,584 cubic yards had been excavated, establishing a channel 50 feet wide, dredged to a depth of from 16 to 18 feet, between Lake Michigan and Black Lake. The excess of depth will allow for shoaling and probably serve to retain a sufficient channel during the rest of the present season of navigation.

The present condition of the works of improvement is as follows:

North pier, comprising 1,137 feet of pile work and 544 feet of crib work, built by the United States, and 169 feet of irregular crib work, built by local enterprise, has a total length of 1,850 feet and projects 550 feet beyond the shore line.

The south pier, comprising 993 feet of pile work and 555 feet of crib work, built by the United States, and 141 feet of irregular crib work, built by local authorities, has a total length of 1,689 feet and projects 670 feet beyond the shore line.

The timber work of both piers is generally in good condition except a length of 228 feet of revetment on the north side, which must be rebuilt above water; filling is lacking throughout the work, and sheet piling is needed to make both piers sand tight.

The proposed depth of 12 feet can not be maintained until the old work is sheet piled, as indicated above, and piers extended to the 15-foot curve in Lake Michigan, which will require an addition of 400 feet to each. Such extension would call for an expenditure of about $75,000, but as it is not yet authorized the item is omitted from the estimate for 1896, which is as follows: For sheet piling 1,492 feet of north and south piers, $8,000; rebuilding 228 feet north revetment above water, $3,000; dredging, $3,000; refilling piers, and minor repairs, $2,500, which, with contingencies, amounts to $18,000.

Appropriations for improving harbor at Holland (Black Lake), Mich.

Black Lake:		Black Lake—Continued.	
*August 30, 1852	$8,000.00	June 14, 1880	$6,000.00
June 23, 1866	55,615.31	March 3, 1881	16,000.00
March 2, 1867	51,000.00	August 2, 1882	10,000.00
July 11, 1870	10,000.00	July 5, 1884	5,000.00
March 3, 1871	10,000.00	August 5, 1886	5,000.00
June 10, 1872	10,000.00	August 11, 1888	5,000.00
March 3, 1873	12,000.00	September 19, 1890	10,000.00
June 23, 1874	15,000.00	Holland:	
March 3, 1875	15,000.00	July 13, 1892	5,000.00
August 14, 1876	15,000.00		
June 18, 1878	10,000.00	Total	279,615.31
March 3, 1879	6,000.00		

Original estimated cost of the work, 1866, amended in 1873, 1879, 1884, and 1892	$291,615.31
Whole amount appropriated, 1852, to and including act of July 13, 1892	279,615.31
Whole amount expended to June 30, 1894	276,883.33

Money statement.

July 1, 1893, balance unexpended	$4,994.05
June 30, 1894, amount expended during fiscal year	2,263.26
July 1, 1894, balance unexpended	2,730.79
July 1, 1894, outstanding liabilities	1,041.57
July 1, 1894, balance available	1,689.22
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	18,000.00

COMMERCIAL STATISTICS, BLACK LAKE HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Tonnage.
Calendar year—		
1889	1,087	80,790
1890		
1891	2.676	178,300
1892	2,800	200,000
1893	2,060	815,150

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by Mr. W. C. Walsh, of Holland, Mich.]

Articles.	Tons.	Articles.	Tons.
RECEIVED.		SHIPPED.	
Brick	3,000	Apples and pears	100
Cedar posts	200	Brick	1,100
Coal	22,000	Coal	8,700
Farm products	10	Farm products	1,880
Flour	50	Fish	10
Furniture	500	Flour	7,000
Grain	500	Fruit, miscellaneous	1,000
Iron and ore	200	Furniture	20,000
Lath	1,150	Grain	590
Leather and hides	5,000	Grapes	36
Lime and cement	1,500	Hay and feed	2.000
Live stock	50	Leather and hides	5,200
Lumber	52,000	Live stock	300
Machinery	900	Lumber	4,500
Merchandise, general	1,300	Machinery	4,200
Paper	500	Merchandise, general	600
Shingles	6,000	Peaches	20,000
Slabs	500	Potatoes	1,200
Stone	150	Shingles	200
Tan bark	10,000	Stone	22,000
Total	106,110	Total	100,616

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*Amount carried to surplus fund, $1.19.

L L 7.

IMPROVEMENT OF GRAND HAVEN HARBOR, MICHIGAN.

This harbor is at the mouth of Grand River, which had a shifting channel with a depth of 9 feet at its mouth before improvement, toward which some steps had been taken by the Detroit, Grand Haven and Milwaukee Railroad Company, whose road terminates at that point, before systematic work was commenced by the Government in 1867, under an appropriation of $65,000 made in the river and harbor act of June 23, 1866. The project adopted was the usual one of protecting the entrance channel by piers projecting into the lake, and dredging as found necessary to make and maintain the necessary depth. The outflow of the Grand River has done much toward keeping such depth inside of the piers, but it also acts toward carrying sand in suspension until the velocity of current is checked on reaching the open lake, sand deposited, and a bar thereby kept constantly forming in advance of the entrance.

At the beginning of the last fiscal year the condition of the harbor was as follows: The north pier and revetment, comprising 1,059 feet of crib work and 2,128 feet of pile work, had a total length of 3,187 feet, and projected 1,215 feet beyond the shore line.

The south pier and revetment, comprising 1,304½ feet of crib work and 4,272 feet of pile work, had a total length of 5,576½ feet, and projected 1,560 feet beyond the shore line.

The depth of water between piers was 17 feet, with a least depth of 15.9 feet on the bar immediately in front of the entrance, while a channel of approach from the south had a depth of 20 feet.

Work for extending both piers had just been commenced, and that of rebuilding a length of 1,631 feet of undermined pile revetment, in a bend on the south side of the river, was in progress by hired labor.

Operations during the past year were as follows:

The Wisconsin Dredge and Dock Company, under contract for extensions of piers, approved January 25, 1893, continued work in progress at the commencement of the year, but with slow progress, largely due to the prevailing financial trouble and difficulty experienced in procuring long timber; their contract called for adding two cribs (each 100 by 30 by 24½ feet) to the south pier, and for extending the north pier 350 feet, by one crib 50 feet long and three cribs each 100 feet long, all on pile foundation; at the beginning of the year Crib No. 1, south pier, had been built to the nineteenth course. It was completed in July, but not sunk in place until September 29; in the meantime the foundation piles, 76 in number, had been driven in water from 25½ to 29½ feet deep, to a penetration of 15 to 18 feet in the bed of the lake, and sawed off to grade 24 feet below water surface at zero of gauge; they were found satisfactory as to line and level when examination was made by the diver before placing the crib in position. The contractors failed to get any other cribs sunk before winter, and all work ceased toward the end of November, after refilling Crib No. 1 to the water surface, covering it by a temporary decking, and placing 50 cords of riprap stone along the foot of the lake-side wall. Operations were resumed April 16, 1894. Seventy-six foundation piles for the remaining south pier crib were driven in water from 25½ to 29½ feet deep, to a penetration of from 15 to 21½ feet in the lake bed and sawed off to grade 24 feet below water surface at zero of gauge; they were found, on examination, satisfactory as respects line and level, and the crib was sunk thereon May 4, 1894. A continuous superstructure, six courses high, was then built over the new cribs, bonded into the old adjoining superstructure, filled with stone, and decked over. Pier-head protection was made by driving 13 guard piles, penetrating to 45 feet below zero of gauge, between the projecting horns of the outer crib, and facing them with 3 horizontal fender timbers secured by screw bolts to the end wall of crib. In the meantime progress was made on the north pier extension as follows: Crib No. 1, 1894 (50 by 30 by 20½ feet), and Crib No. 2, 1894 (100 by 30 by 20½ feet), were completed, the piles for their foundations driven in water from 21½ to 22½ feet deep, to a penetration of 16½ to 19½ feet in the lake bed, and sawed off at grade 20 feet below water surface at zero of gauge, but neither crib had been sunk in place by the close of the year. At that time cribs No. 3 and No. 4 had been built to within 4 and 15 feet respectively of their full height of 20½ feet. It is probable that the whole extension of 350 feet will be completed during the summer.

Extensive repairs were applied to older portions of the work during the year, the principal feature being the partial reconstruction of the south revetment from station 30+32 to station 46+63, a length of 1,631 feet, in continuation of work commenced during the previous year, and described in the last annual report; old superstructure timbers were taken out for a length of 1,100 feet, something over 500 feet having been previously removed; 229 piles were driven in the front row and 56 in the rear row, and sawed off at the water surface; new wale timbers were secured by screw bolts to front and rear rows of piles, and the two rows connected by iron tie-rods; the substructure of piles was then finished with a superstructure of 12 by 12 inch timbers four courses high, and 363 cords of edgings were added to the filling. A board walk 4 feet wide was laid over all the new work, and sixteen mooring posts were secured to the rear wall at uniform intervals. An opening 60 feet wide was left between stations 37+55 and 38+15 to afford access to the deep-water area in rear of the revetment, which provides a secure and compact winter harbor for most of the Government plant used in connection with the improvement of harbors on the east shore of Lake Michigan; a pontoon bridge 4 feet wide locks into the opening and closes it when it is not in use.

Other repairs related to restoring and readjusting filling at numerous points along the old pile work, in connection with which 56 cords of stone were purchased to supply deficiencies.

Frequent soundings were made at the harbor during the year, showing a varying depth of from 15.6 to 17 feet in the channel between piers at entrance; 14.2 to 16 feet on the shoalest part of the bar in front of the entrance, with depths of from 16.5 to 21 feet in the southerly channel over the bar, and from 15.2 to 19 feet in the northerly channel.

The zero of the water gauge at the harbor has been raised 0.28 feet, in compliance with instructions from Chief of Engineers dated December 4, 1893, so as to place its zero 3.06 feet below high water of 1838; the new plane of reference established for harbors on Lakes Michigan and Huron.

The mean stage of Lake Michigan during the fiscal year 1894, referred to the zero of this gauge, was −0.859 feet; the highest stage was +0.5 feet July 8, 1893, and the lowest −2.07 feet December 11, 1893; an extreme fluctuation of 2.57 feet.

The steamers of the Detroit, Grand Haven and Milwaukee Railroad Company maintained an uninterrupted navigation throughout the winter.

The United States dredge *Farquhar*, with dump scows, pile driver; steamer *Hancock* and tugs *Williams* and *Gillmore*, were in winter quarters at this harbor, and while there received such repairs as were needed to fit them for this season's work.

The condition of the harbor June 30, 1894, was as follows:

The north pier, with a total completed length of 3,187 feet, including 1,059 feet of crib work and 2,128 feet of pile work, projected 1,200 feet beyond the adjacent shore line. An extension of 350 feet, by the addition of one crib 50 feet long and three cribs each 100 feet long, was in progress, the 50-foot crib having been sunk in place on its pile foundation June 19.

The south pier had a total length of 5,779 feet, comprising 1,507 feet of crib work and 4,272 feet of pile work, and projected 1,760 feet beyond the adjacent shore line.

The crib work of both piers is in good condition, but the filling of all pile structures is deficient and needs a general overhauling, with considerable additions. A length of 667 feet of old south pile pier from station 11+67 to station 18+34 must be rebuilt above water. The present approved project calls for further extensions of 150 feet and 100 feet to the north and south piers respectively. The depths of water were 17 feet at entrance between piers, 20 feet in southerly channel of approach, and 17 feet in the northerly approach, with a least depth of 16 feet in the middle ground between them and immediately in front of the harbor entrance.

This harbor has an entrance width of 400 feet between piers, and is therefore of great service as a harbor of refuge during the prevalence of all westerly gales; a quality which attaches to no other harbor on this coast, and of inestimable advantage to general commerce.

The estimate for 1896 is as follows: For 250 feet of pier extensions, to complete project, $35,000; for rebuilding 667 feet of south pile pier above water, 6,600; refilling pile revetments and incidental repairs to same, $10,000; for sheet pile revetment north side, 2,500 feet, $15,000; for sand fences and shrub planting to stop drifting of sands into harbor, $7,000; in all, with contingencies, $80,000.

The Light-House Establishment maintains a fourth-order flashing coast light south of the entrance, and a sixth-order harbor light and fog signal on the south pier. There is a life-saving station on the north side near the shore line.

The harbor is at the port of entry for the Michigan collection district, Michigan.

Appropriations for improving harbor at Grand Haven, Michigan.

August 30, 1852 (mouth of Grand River)	$2,000.00	June 18, 1878	$15,000.00
March 2, 1867 (mouth of Grand River)	40,000.00	March 3, 1879	9,000.00
June 23, 1866	65,000.00	June 14, 1880	50,000.00
April 10, 1869	1,866.15	March 3, 1881	50,000.00
July 11, 1870	10,000.00	August 2, 1882	40,000.00
1870 (allotment)	500.00	July 5, 1884	50,000.00
March 3, 1871	6,000.00	August 5, 1886	30,000.00
June 10, 1872	15,000.00	August 11, 1888	25,000.00
March 3, 1873	75,000.00	September 19, 1890	75,000.00
June 23, 1874	50,000.00	July 13, 1892	90,000.00
August 14, 1876	15,000.00	Total	714,366.15

Original estimated cost of the work, 1866, amended in 1880, 1890, and 1892	$804,366.15
Whole amount appropriated and allotted from 1852 to and including act of July 13, 1892	714,366.15
Whole amount expended to June 30, 1894	668,529.52

Money statement.

July 1, 1893, balance unexpended		$76, 165. 95
June 30, 1894, amount expended during fiscal year		30, 329. 32
July 1, 1894, balance unexpended		45, 836. 63
July 1, 1894, outstanding liabilities	$19, 093. 31	
July 1, 1894, amount covered by uncompleted contracts	22, 220. 24	
		41, 313. 55
July 1, 1894, balance available		4, 523. 08
Amount that can be profitably expended in fiscal year ending June 30, 1896. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		80, 000. 00

COMMERCIAL STATISTICS, GRAND HAVEN HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	2, 331	$5, 221. 81	
1885	1, 634	1, 985 43	
1886	1, 384	1, 546. 32	
1887	1, 297		632, 159
1888	1, 888		1, 036, 629
Calendar year—			
1888	1, 508		1, 405. 600
1889	1, 110		649, 370
1890	1, 172		834, 089
1891	819		616, 422
1892	815		693. 835
1893	761		613, 425

Receipts and shipments by vessel, 1893.

[Compiled from statements furnished by R. C. Duryea, and the collector of customs, Grand Haven, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Brick . . . number . .	600, 000	1, 500	Fish . . . barrels . .	200	30
Flour . . . barrels . .	441, 758	44, 176	Flour . . . do	750	75
Gravel . . . cubic yards . .	500	650	Fruit, miscellaneous, packages	20, 780	312
Hay and feed		15, 388	Grain . . . bushels . .	1, 250	34
Iron and ore		6, 040	Hay and feed		88
Leather		863	Hides		110
Lime and cement		7, 332	Iron and ore		1, 296
Lumber . . . feet, B. M . .	5, 230, 000	9, 153	Leather		61
Merchandise, general, packages	8, 103	10, 630	Lumber . . . feet, B. M . .	200, 000	350
Miscellaneous		14, 519	Merchandise, general, packages	8, 510	23, 064
Piles . . . number . .	671	403	Miscellaneous		597
Stone . . . cords . .	538	3, 362	Potatoes . . . bushels . .	2, 650	79
Wood . . . do . . .	600	900	Slabs . . . cords	83	222
Total		114, 916	Total		26, 318

L L 8.

IMPROVEMENT OF MUSKEGON HARBOR, MICHIGAN.

Before the Government did any work at this harbor local enterprise had improved the natural outlet of Muskegon Lake by building slab revetments and piers, thereby obtaining a channel 13 feet deep between them; but entrance to it was obstructed by an outer bar over which the usual channel depth was only 7 feet. Operations were commenced by the Government in 1867 with the purpose of remodeling the old slab piers and extending them by crib work to deep water beyond the bar. This was done, and subsequent extensions followed as necessitated by the steady lakeward progress of the shore line and sand accretions in advance of it. In this way a good channel 12 feet deep was maintained, but the distance between piers was only 180 feet, and to attempt this narrow entrance was a dangerous matter in stormy weather. The scheme of improvement was therefore modified by building a detached pier parallel to and 300 feet from the south pier, the inner end of the new structure being about 120 feet north of the lake end of the old north pier; the opening left thereby introduced a new element of danger, which was obviated by removing a length of 316 feet from the end of the old north pier and building from the point thus reached an oblique wing of crib work, 330 feet long, to the east end of the detached structure.

At the beginning of the last fiscal year the condition of the harbor works was as follows:

The north pier and revetment comprised 502 linear feet of crib work parallel to and 300 feet from the south pier, 329.6 linear feet of crib work in the oblique connecting wing, 322 linear feet of old crib and 392 feet of old pile pier parallel to and about 180 feet from the south pier. The total length of this completed work was 1,545.6 feet, and its lake end was 1,000 feet beyond the shore line. Besides this, two new cribs had just been sunk and filled with stone to the water surface and 786 linear feet of sheet pile revetment had been nearly completed.

The south pier, comprising 382½ feet of pile work and 799½ feet of crib work, had a total completed length of 1,182 feet, of which 980 projected beyond the shore line. Work of pier extension was in progress, one crib 50 feet long having just been sunk and filled with stone to the water surface.

The channel depth was such as to permit the free passage of vessels drawing full 13 feet.

Operations during the fiscal year were as follows:

The work of pier extension, under contract with E. G. Crosby, approved February 23, 1893, was continued until November 11, 1893, when it was completed and contract closed. In these operations Crib No. 3, 1893, north pier (100 by 30 by 20½ feet), and cribs Nos. 2 and 3, south pier (each 100 by 30 by 22½ feet), were built; 76 foundation piles for the north pier crib were driven in water from 21.5 to 24 deep to a penetration of from 15 to 18.5 feet in the lake bed, and sawed off at grade 20 feet below zero; 152 foundation piles for the two south pier cribs were driven in depths of 23.5 to 29 feet to a penetration of from 15 to 19 feet in the lake bed, and sawed off at grade 22 feet below zero; Crib No. 2, south pier, was sunk in place August 2; Crib No. 3, north pier, August 8, and Crib No. 3, south pier, August 26. The foundation piles were examined as to line and level before cribs were sunk, and also afterwards to see that they had true bearings, and everything was found to be satisfactory in this respect. Six courses of continuous superstructure were built over the new cribs in each pier, bonded back into the old pier work, supplied with oak mooring posts at intervals of 50 feet, filled with stone, and decked over. Vertical timbers were driven in crib intervals to close gaps under side walls and retain ballast. Pier-head protection was provided by driving 13 guard piles between the horns of each end crib, penetrating to from 40 to 41.5 feet below zero of gauge, and faced with 3 horizontal fender pieces screw-bolted to the end walls of cribs. Finally, a substantial riprap of stone, weighing not less than 300 pounds each, was placed along the sides of each end crib. The actual extension made to the south pier by the new work was 300.5 feet, and to the north pier 250.5 feet.

The work of completing the sheet-pile revetment that had been commenced during the previous year comprised driving the round and sheet piles of front row, and placing superstructure timbers for a distance of 51 feet, driving 61 anchor piles in rear row, framing and placing rear binders, and placing tie-rods and braces between the front wall and anchor piles. The United States dredge *Farquhar* made a shallow cut along the face of the revetment, and cast the excavated material behind the work to strengthen it against the thrust of passing vessels.

Some minor repairs were made to the old south pile pier, the filling of which was overhauled and increased by the addition of 26½ cords of edgings and 64 cords of stone; two gaps in the front row of piling were filled by driving extra piles which were secured at top by rear binders screw-bolted to adjoining piles; a decking 5 feet wide was laid along the channel wall to protect the filling against seas which, entering the harbor during westerly gales, are so deflected by the oblique portion of the north pier as to mount the work on the south side of the channel.

At the beginning of the year dredging was in progress, under contract with J. T. Farnham, to excavate a channel 100 feet wide, 18 feet deep, and 900 feet long at the entrance to the harbor, and this work was completed July 24, the amount dredged from July 1 to the time of completion, being 2,998 cubic yards. The entrance channel was thereby improved to a depth of 17 feet, but the inner channel afforded less than 14 feet; the United States dredge *Farquhar* was therefore sent to the harbor August 14, and kept at work until November 18, during which period 33,416 cubic yards were excavated, resulting in a through channel 50 feet wide and 18 feet deep from Muskegon Lake to the entrance from Lake Michigan. During a southwest gale of October 6, 1893, about 300 linear feet of old slab and log dock on the south side of the channel, just inside of the Government revetment, was washed away by the heavy seas, exposing the underlying sand, and threatening navigation by its wash into the channel. The attention of the authorities of Muskegon was called to the matter and they at once proceeded to place a new revetment at local expense; a row of close piling was driven across the break in line with channel face of south pier, and 12 feet in rear of it a row of anchor piles from 8 to 12 feet apart; the piles of each row were connected by binding timbers, the two rows by tie-rods, and the space between filled with brush fascines and stone.

The zero of the water gauge at the harbor was raised 0.02 feet so as to place its zero 3.06 feet below high water of 1838, the new plane of reference established for harbors on lakes Michigan and Huron by letter from the Chief of Engineers dated December 4, 1893.

The condition of affairs June 30, 1894, was as follows:

North pier—comprising 1,404.1 feet of crib work, 392 feet of pile-pier revetment, and 786.3 feet of new sheet-pile revetment—had a total length of 2,582.4 feet and projected 1,220 feet beyond the shore line; 322 feet of this crib work was built in 1868–'69, and the timber work above water is now so dilapidated that it can not hold together much longer; new superstructure must be built over this section. About 100 cords of stone are required to refill empty pockets in new crib work, and some minor repairs are needed for the better security and service of the old pile section.

South pier—comprising 1,100 feet of crib work and 382½ feet of pile pier and revetment—had a total length of 1,482½ feet and projected 1,280 feet beyond the shore line. The timber work is generally in good condition, or can be made so at small expense; but the filling of all the older parts of the structure must be overhauled and equalized, and considerable additional stone supplied.

The available depth of channel between the piers, as shown by survey made May 31 to June 5, was 14 feet. The present approved project requires the north pier to be extended 550 feet and the south pier 500 feet, and these extensions should be made without delay in order that the favorable results obtained by those completed last year shall not be lost and the extensive commercial interests centering in this harbor thereby seriously injured. With this done, and the channel dredged to full width and depth, and the older work put in proper repair, it is probable that the improvement will be maintained for a long period with small annual expenditures.

The estimate for 1896 is as follows: For 322 feet new superstructure, old north pier, $3,220; refilling piers and revetments, $2,500; minor repairs, pier and revetments, $1,500; dredging, $5,000; extending north pier 550 feet, and south pier 500 feet, to complete the improvement, $126,000; making, with an allowance of about 8½ per cent for contingencies, a total of $150,000.

The Light-House Establishment maintains a fourth-order coast light on the south shore and a sixth-order harbor light on the south pier. There is a life-saving station on the north pier.

The harbor is in the Michigan collection district, Michigan; nearest port of entry, Grand Haven, Mich.

Appropriations for improving harbor at Muskegon, Mich.

March 2, 1867	$59,000	March 3, 1881	$20,000
July 11, 1870	10,000	August 2, 1882	25,000
March 3, 1871	15,000	July 5, 1884	20,000
June 10, 1872	10,000	August 5, 1886	12,500
June 23, 1874	10,000	August 11, 1888	45,000
March 3, 1875	25,000	September 19, 1890	50,000
August 14, 1876	15,000	July 13, 1892	75,000
March 3, 1879	5,000		
June 14, 1880	7,500	Total	404,000

Original estimated cost of the work, 1866, amended in 1869, 1873, 1877, 1884, 1890, and 1892	$589,000.00
Whole amount appropriated from 1866 to and including act of July 13, 1892	404,000.00
Whole amount expended to June 30, 1894	402,461.38

Money statement.

July 1, 1893, balance unexpended	$70,636.30
June 30, 1894, amount expended during fiscal year	69,097.68
July 1, 1894, balance unexpended	1,538.62
July 1, 1894, outstanding liabilities	401.53
July 1, 1894, balance available	1,137.09
Amount that can be profitably expended in fiscal year ending June 30, 1896	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, MUSKEGON HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	7,160	$4,987.06	
1885	6,112	1,621.34	
1886	5,543	1,025.17	
1887	1,745		232,007
Calendar year—			
1888	2,685		
1889	4,626		884,869
1890	3,786		649,540
1891	2,886		704,046
1892	4,174		740,021
1893	2,482		834,049

During the year a triweekly line of passenger and freight steamers was established between Muskegon, Mich., and Sheboygan, Wis.

Receipts and shipments by vessel, 1893.

[Compiled from statements furnished by Hon. H. H. Holt, and collector of customs, Muskegon, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Bran		1,502	Beer ... kegs	4,400	400
Brick ... number	950,870	2,377	Canned goods ... cases	6,901	224
Cedar posts ... M	2,823	56,460	Crackers ... packages	18,175	182
Flour		2,071	Curtain rollers ... bundles	23,380	1,169
Furniture		3,271	Flour		501
Grain		4,317	Furniture		511,007
Gravel		9,114	Hoops		496
Iron		418	Iron		2,718
Lath ... M	505,709	151,712	Lath ... M	2,139	642
Leather		3,600	Lime and cement		5,079
Lime and cement		2,187	Lumber ... M feet, B. M	91,801	160,652
Lumber ... M feet, B. M	26,607	47,062	Merchandise		291,551
Malt		403	Miscellaneous		32,459
Merchandise		281,882	Plaster		5,846
Miscellaneous		21,275	Pickets ... M	850	1,488
Plaster		310	Pianos ... number	500	250
Pickets ... number	4,970,070	8,698	Refrigerators		381
Pulp, paper		300	Sawdust		4,322
Rags		205	Shingles ... M	6,046	756
Sugar		536	Slabs ... cords	25,211	66,724
Stone		25,910	Sugar ... barrels	15,004	3,751
Stucco		897	Tar		225
Vinegar		202			
Total		624,709	Total		1,090,823

L L 9.

IMPROVEMENT OF WHITE LAKE HARBOR, MICHIGAN.

Before improvement by the Government, White Lake had a narrow and winding outlet into Lake Michigan, which had been improved by local enterprise so as to permit vessels drawing about 5 feet to pass through. The construction of the present harbor was commenced in 1867 by making a straight cut from lake to lake, about 1,200 yards south of the old outlet; the project being to establish thus a channel 12 feet deep and 200 feet wide, protected by revetments and piers extending into Lake Michigan at an estimated cost of $170,530.80. This project has been steadily followed until the present time, but the rapid accretions of sand against the piers as their projection into Lake Michigan advanced, have thus far prevented the establishment of a channel of the proposed depth; it has been repeatedly dredged to depths of from 12 to 16 feet, but shoaling to 9 or 10 feet invariably follows in a short time. It is not probable that a depth of 12 feet can be maintained for any considerable period, until the piers are carried out to the 15-foot curve in Lake Michigan and kept there.

The condition of the improvement June 30, 1893, was as follows:

The north pier is a close pile structure 1,515 feet long, and projected 390 feet beyond the shore line into Lake Michigan.

The south pier, consisting of 1,498 feet of pile work and 356 feet of crib work had a total length of 1,854 feet and projected 730 feet beyond the shore line into Lake Michigan.

The channel depth at entrance was 10½ feet.

The only work done at the harbor during the past fiscal year was some dredging by the United States dredge *Farquhar*. Commencing July 1, 1893, operations were continued until August 12, when 14,216 cubic yards had been dredged, resulting in a straight channel 50 feet wide, with a midchannel depth of 14 feet, from lake to lake. The commercial requirements were thereby satisfied until the close of the season of navigation, but when the harbor was surveyd May 28–29, 1894, the channel depth had shoaled to 10¾ feet.

During the year the shore line adjoining the north pier was advanced by accretions about 30 feet and that adjoining the south pier 20 feet, so that these piers now project beyond the shore line only 360 and 710 feet, respectively, instead of 390 and 730 feet as was the case a year ago.

The north pier is generally in fair condition, except that a few piles need to be made more secure, and a general overhauling of the filling, composed of stone and edgings, is necessary to prevent stone from passing through the spaces between piles.

The south pier is not in such good condition; the end crib has settled badly, and this settlement continues, with indications of a tendency to slide outwards; the above-water portion between stations 3 × 56 and 7 × 23, comprising a length of 367 feet, built from twenty-two to twenty-four years ago, is badly dilapidated and must be rebuilt. The filling needs to be overhauled throughout, and new material must be supplied in places where it has settled to below the water surface.

The limits of pier extension at present authorized are 250 feet for the north, and 200 feet for the south pier, but the end of the former is nearly 100 feet inside (shoreward) of the 9-foot curve, while the latter is about 150 feet outside of it. It is quite clear that better results will be obtained by extending the north pier 350 feet and the south pier 100 feet; such extensions would place the end of the former about 200 feet, and of the latter about 150 feet inside of the present 15-foot curve.

The estimate for 1896 is as follows: For pier extension 450 linear feet, $50,000; for rebuilding 367 linear feet of south pier above water, $3,670; miscellaneous repairs of piers and revetments and dredging, $5,000; making in all, with about 6 per cent for contingencies, $62,000.

The harbor is in the Michigan collection district, Michigan; nearest port of entry, Grand Haven, Mich. The Light-House Establishment maintains a fourth-order flashing coast light on the shore; and a sixth-order harbor light on the south pier. There is a life-saving station on the north pier.

Appropriations for improving harbor at White Lake, Mich.

March 2, 1867	$57, 000	June 14, 1880	$5, 000
April 10, 1869	44, 550	March 3, 1881	7, 500
July10, 1870	20, 000	August 2, 1882	12, 000
March 3, 1871	20, 000	July 5, 1884	10, 000
June 10, 1872	10, 000	August 5, 1886	10, 000
March 3, 1873	7, 000	August 11, 1888	10, 000
June 23, 1874	10, 000	September 19, 1890	17, 000
March 3, 1875	10, 000	July 13, 1892	5, 000
August 14, 1876	5, 000		
June 18, 1878	12, 000	Total	279, 550
March 3, 1879	7, 500		

Original estimated cost of work, 1866, amended in 1873, 1884, and 1892	$337, 550. 00
Whole amount appropriated 1866 to and including act of July 13, 1892	279, 550. 00
Whole amount expended to June 30, 1894	274, 835. 08

Money statement.

July 1, 1893, balance unexpended	$7, 394. 37
June 30, 1894, amount expended during fiscal year	2, 679. 45
July 1, 1894, balance unexpended	4, 714. 92
July 1, 1894, outstanding liabilities	4. 30
July 1, 1894, balance available	4, 710. 62
Amount (estimated) required for completion of existing project	58, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	62, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, WHITE LAKE HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	304	$1, 347. 23	....
1885	1, 416	476. 16	....
1886	1, 623	313. 65	....
1887	1, 885	....	262, 440
1888	1, 742	....	184, 247
Calendar year—			
1888	1, 408	....	147, 142
1889	732	....	....
1890	579	....	62, 276
1891	405	....	47, 135
1892	392	....	58, 950
1893	260	....	1, 052, 026

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by the collector of customs.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED—continued.		
Coal	....	39	Cedar posts ..... number	5, 000	100
Flour ..... barrels	50	5	Grain ..... bushels	20, 000	550
Grain ..... bushels	11, 335	312	Lumber ... M. feet, B. M.	1, 676	2, 933
Miscellaneous	....	153	Miscellaneous	....	150
			Potatoes ..... bushels	4, 160	125
Total	....	509	Shingles ..... number	198, 000	25
			Slabs ..... cords	6, 427	17, 138
SHIPPED.			Total	....	21, 084
Brick ..... number	25, 000	63			

L L 10.

IMPROVEMENT OF PENTWATER HARBOR, MICHIGAN.

The Governmental improvement of this harbor was commenced in 1867, but before that time a narrow channel, about 4 feet deep, had been made by local action to connect Pentwater Lake with Lake Michigan. The project then adopted was to increase the channel width and depth to 150 and 12 feet respectively, and protect the channel by lateral piers extended into Lake Michigan; the estimated cost was $327,713.40. Work on this project has been in progress ever since, but the depth of 12 feet has not yet been obtained except for short periods following immediately after dredging, the piers having never been long enough to maintain such depth.

The condition of the harbor June 30, 1893, was as follows:

The north pier had a total length of 2,223 feet, of which 1,821 is pile revetment and 402 crib work; it projected 590 feet beyond the shore line.

The south pier, comprising 1,392 linear feet of pile revetment and 723 feet of crib work, had a total length of 2,115 feet, and projected 530 feet beyond the shore line.

The depth of channel between piers was about 11 feet.

Operations of the past fiscal year were commenced July 24, 1893, by the United States dredge *Saginaw*, which was sent there to deepen the channel. This work was continued until August 22, when 14,575 cubic yards of sand had been excavated, making channel 70 feet wide and 16 feet deep. Before the close of the year this channel had shoaled again to 10½ feet, as shown by a survey of the waterway between piers made May 25–26, 1894. Toward the close of year a small force was organized to make some urgent repairs to the old pier structure, such as replacing some of the timbers that had become so rotten or broken as to be useless, and patching up the larger holes through which stone and sand leaked in considerable quantities. This work was still in progress, but nearly completed, at the end of the year.

The foregoing indicates all that was done during the year. The repairs will help to hold old work together until it can be rebuilt. The dredging served to give sufficient depth for commercial requirements during the year, but the channel thereby made is entirely obliterated now.

The piers reach out but little beyond the 10-foot curve in Lake Michigan, and for this reason a navigable depth of more than 9 feet can not be kept; dredging serves only to give greater depths for periods of greater or less duration, depending on the extent to which the bed of Lake Michigan may be affected by storms. The depth of 12 feet called for by the approved project can only be held with any reasonable permanence when the piers shall have been extended to the 15-foot curve—now from 300 to 400 feet distant. The limit of extension at present authorized is 200 feet only for the south and nothing for the north pier. The estimate below, being simply in conformity therewith, might be misleading as to the real requirements of this harbor if the foregoing facts were not clearly stated.

The old portions of both piers must be rebuilt above water, especially that of the south pier.

The estimate for 1896 is: For rebuilding above water and refilling 520 linear feet north pier, $5,210; same for 1,036 feet of south pier, $10,360; dredging, $3,000; 200 linear feet new crib work for completing

authorized extension of south pier, $24,000—making, with about 6 per cent for contingencies, $45,000.

The harbor is in the Michigan collection district, Michigan; nearest port of entry, Grand Haven.

The Light-House Establishment maintains a pier and range light near the outer end of the south pier, and there is a life-saving station about middle of north pier.

Appropriations for improving harbor at Pentwater, Mich.

March 2, 1867	$55,000	March 3, 1881	$10,000
April 10, 1869	17,820	August 2, 1882	10,000
July 11, 1870	10,000	July 5, 1884	15,000
March 3, 1871	10,000	August 5, 1886	10,000
June 10, 1872	30,000	August 11, 1888	8,000
March 3, 1873	20,000	September 19, 1890	8,000
August 14, 1876	10,000	July 13, 1892	5,000
June 18, 1878	10,000		
March 3, 1879	6,000	Total	238,820
June 14, 1880	4,000		

Original estimated cost of improvement, 1867	$327,713.40
Total appropriated to June 30, 1894	238,820.00
Total expended to June 30, 1894	234,162.38

Money statement.

July 1, 1893, balance unexpended	$6,452.73
June 30, 1894, amount expended during fiscal year	1,795.11
July 1, 1894, balance unexpended	4,657.62
July 1, 1894, outstanding liabilities	350.04
July 1, 1894, balance available	4,307.58
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	45,000.00

COMMERCIAL STATISTICS, PENTWATER HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	461	$400.93	
1885	187	69.17	
1856*			
1887*			
Calendar year—			
1888	300		45,000
1880*			
1890	27		2.559
1891	1,140		71,260
1892*			
1893	116		

* Not stated.

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by the mayor of Pentwater, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Coal		75	Cedar posts.....number..	38,715	774
Furniture		500	Furniture		1,500
Grain............bushels..	10,000	275	Laths............number..	204,000	61
Hay and feed		50	Lumber.......feet, B. M..	4,480,802	7,841
Lumber........feet, B.M ..	500,000	875	Peaches.........baskets..	50,000	300
Salt...............barrels..	500	70	Potatoes........bushels..	30,000	900
			Slabs..............cords..	114	153
Total		1,845	Tan bark............do....	872	872
			Ties..............number..	4,500	405
			Total		12,806

Six million feet of lumber and 12,000,000 shingles were on the wharves awaiting shipment at the end of the calendar year.

L L II.

IMPROVEMENT OF LUDINGTON HARBOR, MICHIGAN.

The Government's part in the development of this important commercial harbor dates from 1867, when private enterprise had made, and for some years maintained, a narrow channel with a depth of 7 feet from Lake Michigan to Pere Marquette Lake. The plan of improvement then adopted was to dredge the channel to a depth of 12 feet, widen it to 200 feet, and protect its projection into Lake Michigan by lateral piers; the estimated cost was $270,682. The improvement was duly made, and subsequently maintained by periodical dredging and occasional pier extensions until 1885-'86, when the north pier comprised a length of 951 feet, all crib work, and the south pier and revetment 1,679½ feet, of which 567 feet was pile work, and the remainder cribs. In the meantime, the idea of establishing a harbor of refuge was advanced in 1880 and several projects with that object in view were prepared, with estimates of cost varying from $500,000 to $1,500.000; finally, in 1885, one was adopted which provided for a depth of 18 feet, and for replacing the south pier by a new one 200 feet farther south, so as to increase the width of channel between piers to 400 feet; the estimated cost was $419,185. It is fortunate that the lack of commensurate appropriation and of authority to accept land necessary for widening the channel as proposed, delayed the commencement operations on this project until it was recognized that such a wide opening from Lake Michigan directly into Pere Marquette Lake would permit such a free transmission of wave force and motion as to seriously impair the fitness of the harbor for commercial purposes. The harbor of refuge project was therefore, in 1890, transformed into one which, by dredging and pier extension, contemplated a channel 18 feet deep and 250 feet wide at entrance, without change of existing width within the limits of piers already built; the estimated cost of this modification was $111,000. Work thereon was promptly commenced, and in 1891 the necessary pier extension had been completed, adding 500 feet to the north and 700 feet to the south pier. By dredging, the channel depth has been maintained at from 14½ to 16½ feet; but the full depth of 18 feet has not yet been secured. The condition of the harbor, June 30, 1893, was as follows:

The north pier had a total length of 1,452 feet, all crib work, and projected 930 feet beyond the shore line.

The south pier had a total length of 2,381 feet, of which 567 feet was old pile work and 1,814 feet of crib work, and it projected 1,500 feet beyond the shore line.

The available channel depth was 14½ feet.

Operations during the last fiscal year were as follows:

The United States dredge *Saginaw* was at work when the year opened, with the object of deepening the entrance channel, and continued operations until July 22, when a through channel with a minimum depth of 16 feet was secured. The amount excavated in the fiscal year was 13,802 cubic yards.

During the same month (July) the Wisconsin Dredge and Dock Company, under an agreement previously made, placed 343.8 cords of stone in the outer portions of the south pier, where the filling had settled to such an extent as to threaten its security. No other work was done during the year, except to make such occasional surveys or examinations as were required to afford information regarding the navigable condition of the harbor.

The condition of the harbor, June 30, 1894, was substantially the same as at the beginning of the year, except that the navigable depth had been increased from 14½ to 16¼ feet.

The new pier work is all in excellent condition, but a large portion of the older structures are so decayed and dilapidated that ordinary repairs can no longer be depended upon to keep them together; they must be rebuilt as soon as practicable. These repairs and dredging to maintain the requisite navigable depth for established commerce are the only matters for which provision is needed in the next appropriation for this harbor; and the estimate for 1896 is accordingly as follows: Rebuilding inner end of north pier, 130 feet, $2,600; rebuilding, above water, 587 linear feet of north pier, $5,870; rebuilding, above water, 1,423 linear feet of south pier and revetment, $14,230; miscellaneous repairs and stone to provide for settlement of filling in new work, $5,000; dredging, $4,000, which, with 10 per cent for contingencies, makes $34,870, or in round numbers, $35,000.

The harbor is in the Michigan collection district, Michigan; nearest port of entry, Grand Haven, Mich.

The Light-House Establishment maintains a sixth-order light near the end of the south pier, and there is a life-saving station near the inner end of the north pier.

Appropriations for improving harbor at Ludington, Mich.

March 2, 1867	$50,000	March 3, 1879	$5,000
April 10, 1869	31,185	June 14, 1880	8,000
July 11, 1870	10,000	March 3, 1881	10,000
March 3, 1871	10,000	August 2, 1882	12,000
*June 10, 1872	10,000	July 5, 1884	10,000
March 3, 1873	25,000	August 5, 1886	56,250
June 23, 1874	20,000	August 11, 1888	60,000
March 3, 1875	10,000	July 13, 1892	5,000
August 14, 1876	10,000		
June 18, 1878	15,000	Total	357,435

Original estimated cost of work, 1867	$270,682.00
Estimated cost of enlarged project of 1890	111,000.00
Total	381,682.00
Total appropriated to June 30, 1894	357,435.00
Total expended to June 30, 1894	355,518.93

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* Amount carried to surplus fund, 90 cents.

Money statement.

July 1, 1893, balance unexpended	$7,459.09
June 30, 1894, amount expended during fiscal year	5,543.92
July 1, 1894, balance unexpended	1,915.17
July 1, 1894, outstanding liabilities	1.70
July 1, 1894, balance available	1,913.47
Amount that can be profitably expended in fiscal year ending June 30, 1896	35,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, LUDINGTON HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	2,047	$1,451.81	
1885	1,468	425.57	
1886	1,565	520.57	
1887	1,442		259,800
1888	1,511		270,316
Calendar year—			
1888	1,778		277,074
1889	1,759		
1890	2,270		461,997
1891	2,420		610,057
1892	1,969		538,568
1893	979		211,438

Receipts and shipments by vessel, 1893.

[Compiled from statements furnished by the Flint and Pere Marquette Railroad Company, and the collector and deputy collector of customs.]

Articles.	Tons.	Articles.	Tons.
RECEIVED.		SHIPPED.	
Apples and potatoes	109	Apples	1,523
Agricultural implements	81	Cedar posts	865
Brick, cement, etc	1,957	Flour	70
Coal	4,775	Fruit, miscellaneous	1,218
Flour	71,610	Furniture	440
Fruit, miscellaneous	494	Grain	217
Furniture	313	Hay and feed	44
Grain	47,751	Iron ore, and steel	519
Hay, feed, etc	10,185	Lath	309
Hides and leather	2,290	Live stock	79
Live stock	211	Lumber	122,867
Lumber	420	Machinery and castings	115
Machinery	242	Merchandise, general	41,328
Merchandise, general	10,959	Salt	95,918
Miscellaneous	2,418	Shingles, slabs, staves, etc	4,284
Oils	171	Stone	437
Salt	353	Tan bark	7,643
Stone	2,844	Telephone poles	105
Wool	247	Ties	540
Total	157,430	Total	278,521

L L 12.

IMPROVEMENT OF MANISTEE HARBOR, MICHIGAN.

The improvement of this harbor by the Government has been in progress since 1867, local enterprise having previously constructed slab piers on each side of the mouth of the Manistee River, so as to obtain entrance temporarily for vessels drawing 7 feet, which was also the limiting depth that could be carried over bars in the river until deep water was reached in Manistee Lake, about 1¾ miles from Lake Michigan. The project of improvement then adopted was to construct two parallel piers of cribs extending about 960 feet into Lake Michigan to the 12-foot curve, using the slab piers, in part, as foundation for the new work, and to dredge a channel 12 feet deep between piers. The estimated cost of the proposed work was $180,949, and did not provide for any improvement inside the river eastward of the shore end of piers. But when, in 1873, 1,275 feet of crib piers had been built, and an entrance afforded for much greater draft than could be carried in the river, the scope of operations was extended to include straightening its lower reach by dredging, and revetting its banks so far as necessary to preserve the improved channel and to prevent the lake from breaking into the river around the shore end of the north pier. This was accomplished by 1878, when the total length of revetment built was 1,828 feet, of which 1,338 was on the north and 490 on the south side of the river. In the meantime the crib piers had been continued lakeward, but not so fast as to keep pace with the advance of sand accretions, which by this time had become so great as to reduce the depth of water at entrance to 8 feet, or nearly what it was in the beginning. Accordingly, subsequent operations were confined to pier extensions and repairs necessary for maintaining the older structures, with the object of regaining and preserving a channel 12 feet deep at the entrance and between piers. But this depth soon ceased to satisfy the requirements of commerce, and in 1890 the project of improvement was modified to increase it to 15 feet, not only between the piers but throughout the length of the Manistee River. The approved project for accomplishing this object provided for an extension of the north pier to the 18-foot curve in Lake Michigan, a distance of 550 feet; for extending the south pier to the 14-foot curve on the outer bar, then 350 feet distant; and for dredging channel 100 feet wide between the piers to the new 15-foot depth, and thence through the river to Manistee Lake a channel of like depth 50 feet wide. Entering at once upon the execution of this project, contracts for the necessary dredging and for the north pier extension were entered into. The work of dredging was completed in 1892, and that of pier extension was still in progress at the beginning of the last fiscal year.

The condition of the harbor July 1, 1893, was as follows:

The newly dredged channel had deteriorated somewhat, so that the navigable depth was reduced in some places to less than 14 feet.

The north pier and revetment had an aggregate length of 2,605.5 feet, comprising 1,304 feet of pile revetment and 1,301.5 feet of crib work, the lake end being 880 feet in advance of the shore line and 300 feet from the point to which it was to be carried as provided in the approved project; the last 50 feet of crib work had just been sunk in place and was without superstructure.

The whole length of south pier, comprising 490 feet of pile revetment and 1,199 feet of crib work, was 1,689 feet, its lake end being 650 feet beyond the shore line and 350 feet from the limit to which it is to be extended, no work on the proposed extension of this pier having been commenced up to that time.

Work on the north pier extension was in progress under contracts with the Wisconsin Dredge and Dock Company, dated December 24 and 26, 1892, and had been carried to the extent of sinking one crib, 50 by 30 by 18½ feet, on its pile foundation, and crib No. 2, 100 by 30 by 18½ feet, had been built and was ready for sinking; cribs No. 3, of same size as No. 2, and No. 4, 100 by 30 by 20½ feet, had been built to the tenth and second courses, respectively; all the foundation piles for crib No. 2, and 6 for No. 3, had been driven, and 68 of those for No. 2 sawed off to grade.

Commencing with these conditions, operations during the year just past were as follows:

In continuation of the north pier extension the contractors sunk crib No. 2 on its pile foundation July 16, No. 3 in like manner August 7, and No. 4 August 22. These operations involved driving 146 foundation piles and sawing off 160 at the proper grades below water to complete the foundation for the cribs, the addition of 8 and 18 courses to cribs 3 and 4, respectively, to complete them in readiness for sinking, and the placing of 1,915.97 cords of stone for filling the three cribs when sunk. Before sinking crib No. 2 an examination of the foundation was made by a diver, disclosing that two of the piles were out of line so much as to make it necessary to drive new ones in proper place. It was also found that several of the piles had been sawed off below the correct level, and such errors were satisfactorily adjusted by the introduction of hard wood shims between crib sills and tops of piles. After Nos. 3 and 4 had been sunk four of the piles were found not to be in proper contact with cribs, and this difficulty was overcome by bolting timbers to the piles so as to furnish the necessary bearing. After the cribs were in place the openings under the north side walls in crib intervals were closed by vertical timbers extending from the top of cribs to the lake bottom, and thirteen guard piles were placed in front of the end cross wall, between projecting horns of the outer crib.

In the meantime Crib No. 1, which had been sunk in June without reaching the pile foundation, because of sand that had filled over the heads of piles, had settled to its proper grade and bearing. The work of placing six courses of superstructure, continuous over the four cribs and connecting back into that of the older work, was thereupon commenced and completed during September; three horizontal fender timbers were placed outside of guard piles at the outer end of the work, and securely bolted to crib and piles; seven oak mooring posts were placed at intervals of 50 feet in the new work; 180 cords of heavy stone were placed as riprap around the outer end of pier and along its faces for a distance of 250 feet back. By November the superstructure was completed, filled with stone and decked over, and contract closed. The actual length of extension made by the one 50-foot and three 100-foot cribs, was 351½ feet, the present project, so far as it related to this pier, being thereby accomplished.

The total of payments to the contractor, on account of the work, was $32,333.13, made up of items as follows:

509,544 feet, B. M., hemlock timber, at $16.50	$8,407.47
231,082 feet, B. M., white pine timber, at $21.50	4,968.27
1,440 feet, B. M., white oak timber, at $39	56.16
25,477.5 feet, B. M., white pine plank, at $15	382.16
631.3 linear feet hemlock timbers, 12 inches square, at 40 cents	252.52

5,545.9 linear feet foundation piles, at 58 cents	$3,216.63
594.7 linear feet guard piles, at 22 cents	130.83
8,037.7 pounds S. & W. bolts, at $3.95	317.49
88,580.98 pounds drift bolts, at $2.90	2,568.85
1,448.5 pounds spikes, at .04 cents	57.94
1,915.97 cords stone, at $6.25	11,974.81
Total	32,333.13

Work by day labor, for repairs of old parts of old structures, had been started early in the season and was well under way at the commencement of the year, at which time the requisite timber and iron furnished under contract made April 17, 1893, had been delivered; these repairs contemplated the rebuilding above water of about 515 linear feet of piers and revetments, 130 feet of which was on the south and the remainder on the north side. Commencing on the latter at Station 11+12, adjoining the Life-Saving Station, the stone and slab filling was removed for a distance of 378 feet, and 59 cords of stone were transferred to fill up vacant spaces in the south pier; the old timber work was removed, down to the water surface, between stations 11+12 and 14+94, piles in the revetment portion from 11+12 to 12+38 being sawed off 0.2 feet below zero of gauge. A new superstructure, consisting of four or five courses in the front wall and two or four in the rear, was then built, and the necessary filling of edgings and stone put in place. Between stations 18+54 and 18+84 the old crib work projected some 10 feet north of the pier line and was badly dilapidated; the projecting portion was leveled at the water surface and substantially decked with timbers 12 inches thick. The repairs of the south pier extended from Station 0 to 1+30, and were in all respects like those described for the north pier; the old work was torn out to the water surface, new superstructure built, and filling placed in the new work. A double row of sheet piling was placed against the rear wall of the piers, as required to prevent the wash of sand backing into the channel; this sheet piling extended from Station 11+12 to Station 15+60 in the north pier, and from Station 0 to Station 2+71 south pier; in all, 719 linear feet. Board walks were built over the repaired work, that on the north side being 4 feet wide and 384 feet long, and on the south side 3 feet wide, 130 feet long. In addition to these general repairs some scattering work was done in the way of replacing broken and decayed timbers, and refilling with stone as found necessary. The cost of repairs made was $2,742.20 for labor, and for material $3,984.75; total, $6,726.95.

The United States dredge *Saginaw* was sent to this harbor to restore the requisite channel depth between the Government piers and revetments, which had shoaled to 13 feet, and commencing September 13 work was continued to November 21, when the dredge went into winter quarters. The work accomplished was a channel 18 feet deep, 70 feet wide, extending from the inner end of the north revetment westward to the 20-foot curve in Lake Michigan, a distance of 2,700 feet. The total amount dredged was 45,798 cubic yards.

A new and complete survey of the harbor and river was made in August, 1893, and platted during the winter.

In December the zero of the water gauge at the harbor was lowered 0.11 feet in compliance with instructions from the Chief of Engineers, dated December 4, 1893, so as to place its zero 3.06 feet below high water of 1838, the new plane of reference established for harbors on lakes Michigan and Huron. The new zero is in that plane.

The condition of the harbor June 30, 1894, was as follows:

The available depth of water at entrance was 15.7 feet; thence up to the end of the Government revetment 16 to 17 feet; from that point up to Lake Manistee 13½ feet.

The north pier and revetment have a combined length of 2,906½ feet, of which 1,304 feet is revetment and 1,602½ feet crib pier. It extends 1,250½ feet beyond the shore line, and its end coincides with the present curve of 18 feet depth in the lake. The work above water must be rebuilt from stations 14+94 to 18+94 to maintain it in serviceable condition, this portion of the structure having been built from twenty-two to twenty-four years ago.

The south pier comprises 490 feet of pile revetment and 1,199 feet of crib work; the lake end is 699 feet in advance of the shore line, and 350 feet shoreward of the 14-foot curve to which the pier is to be extended in order to complete the present approved project. The preservation of the entrance channel calls for this extension at the earliest date practicable. It is also essential that the work above water be renewed in the near future over that portion of the pier built between the years 1868 and 1872; this comprises a section 516 feet long, extending from Station 1+30 to Station 6+46. The stone filling requires overhauling from the shore line to the outer end, and additional stone is needed at several points to make the work reasonably secure.

In relation to the 490 feet of pile revetment mentioned at the beginning of the foregoing paragraph, I would state that it was built in 1874-'75, by the Government, in extension of the pier up the river, but its site has been occupied for many years by Canfield & Wheeler Lumber Company; the piles have nearly disappeared, and have been replaced with slabs, presumably by the company, as the old revetment crumbled away under its superincumbent loads of lumber. It seems proper that it should no longer be considered or included as a part of the Government work, and it is therefore proposed to ignore it in future reports.

The river is now crossed by three bridges between lakes Michigan and Manistee, the last of which was built by the city of Manistee during the past year, under authority granted by the Secretary of War, as provided in Section 3 of the river and harbor act approved July 13, 1892. The approval of the location and plan of this bridge were predicated on the guarantee of the city to cause the docks on the south side of the river, for a distance of about 500 feet above and 250 feet below the site of the bridge, to be moved back to the dock line established by city ordinance; the city also agreed to dredge a channel 14½ feet in depth through the south draw of the bridge to the river channel above and below, as the draw pier of the bridge was located in mid-river thereby obstructing the channel dredged by the Government two years ago.

These conditions were to be executed by or before July 1, 1894, but the city has failed to fulfill them.

By an instrument dated May 31, 1893, the Secretary of War authorized the Manistee and North Eastern Railroad Company to occupy the revetment built by the Government on the north side of the river, from station 0 to station 7+60. The consideration on which this authority was accorded was the promise and agreement of the railroad company to rebuild the revetment, and maintain it in substantial repair. The company is now in full occupation of the premises, but thus far has failed and refused to make any of the stipulated repairs.

The estimate of funds needed for completing the approved project of improvement, and for the maintenance and repairs of existing works during the year ending June 30, 1896, is as follows: For extending south pier 350 feet, $42,000; rebuilding 400 linear feet of north pier from water level, $4,000; rebuilding 516 feet of south pier from water level, $5,000; minor repairs of revetment, $1,000; dredging, $4,000; total, including contingencies, $61,000.

The Light-House Establishment maintains a sixth-order light and a steam fog signal at the harbor. They were on the south pier until about a month ago, but are now on the north pier.

The harbor is included in the Michigan collection district, Michigan. The nearest port of entry is Grand Haven, Mich.

Appropriations for improving harbor at Manistee, Mich.

March 2, 1867	$60,000	June 4, 1880	$10,000
July 11, 1870	20,000	March 3, 1881	10,000
March 3, 1871	9,000	August 2, 1882	15,000
June 10, 1872	10,000	July 5, 1884	10,000
March 3, 1873	10,000	August 5, 1886	10,000
June 23, 1874	10,000	August 11, 1888	10,000
March 3, 1875	25,000	September 19, 1890	50,000
August 14, 1876	14,000	July 13, 1892	50,000
June 18, 1878	15,000		
March 3, 1879	10,000	Total	348,000

Original estimated cost of works, 1866, as amended in 1871, 1875, and 1890, and 1892	$408,000.00
Whole amount appropriated from 1866 to and including act of July 13, 1892	348,000.00
Whole amount expended to June 30, 1894	345,665.08

Money statement.

July 1, 1893, balance unexpended	$45,889.85
June 30, 1894, amount expended during fiscal year	43,554.93
July 1, 1894, balance unexpended	2,334.92
July 1, 1894, outstanding liabilities	127.61
July 1, 1894, balance available	2,207.31
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	61,000.00

COMMERCIAL STATISTICS, MANISTEE HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year—			
1884	3,609	$3,181.19	
1885	3,560	1,145.29	
1886	3,352	634.26	
1887	3,412		991,872
1888	3,459		889,879
Calendar year—			
1888	3,595		966,221
1889	3,524		945,329
1890	3,691		975,049
1891	3,617		1,079,818
1892	4,044		1,028,629
1893	2,831		959,550

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by the collector of customs, Manistee, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Brick............number..	315,000	788	Cedar posts .....number..	31,175	624
Coal........................	....	1,140	Fish........................	....	592
Flour ....barrels..	47,409	4,741	Lath ....M..	7,351	2,205
Grain............bushels..	519,470	14,285	Lime and cement.barrels..	1,000	105
Hay and feed................	....	2,300	Lumber ....M feet, B. M..	390,766	683,841
Leather	....	30	Merchandise, general......	....	3,231
Lime and cement............	....	886	Potatoes.........bushels..	89,287	2,679
Live stock.........heads..	167	89	Salt ....barrels..	1,375,677	192,595
Merchandise, general.......	....	26,137	Shingles ....M..	110,430	13,804
			Slabs ....cords..	2,986	8,026
Total.....................	....	50,396	Ties ....number..	30,000	2,700
			Tan bark ....cords..	7,337	7,337
			Total.....................	....	917,739

L L 13.

IMPROVEMENT OF HARBOR OF REFUGE AT PORTAGE LAKE, MICHIGAN.

The river and harbor act of June 18, 1878, directed that a survey be made at this place "with a view to its adaptability as a harbor of refuge," and called for an estimate of cost of such harbor.

The conditions then existing were a dangerous coast line extending 175 miles from Grand Haven to Traverse Bay, Michigan, with no intermediate harbor into which vessels might safely attempt an entrance for shelter from the frequently recurring and disastrous Lake Michigan gales. Under these conditions a record of shipwreck and life loss had been made that clearly established the great necessity for increased security to lake commerce and travel in this locality, and the question was presented as to the adaptability of Portage Lake to this purpose; the survey thereupon made answered the question, and showed that the site offered peculiar advantages. The lake was found to include an area of nearly 4 square miles where the water was from 4 to 7 fathoms deep; it was landlocked, save where connected with Lake Michigan by an artificial ditch, in which the water was only 4 feet deep at the time of survey; yet the barrier separating the waters of the lakes was only 30 rods wide at its narrowest part, and its distance between 18-foot depths in the two was only 2,000 feet. The project then presented, with every confidence that the needed harbor of refuge might soon be an accomplished fact, was to dredge a channel 18 feet deep from lake to lake and protect it between parallel piers and revetments 300 feet apart; its estimated cost was $189,860, and, small as the amount was, it would undoubtedly have been found ample if appropriations at all adequate to any reasonable degree of progress had been provided for doing the work. But the first one made by the act of March 3, 1879, was only $10,000, and with this paltry sum the work of making the much-needed harbor of refuge was inaugurated; but the officer in charge plainly reported that it could never be accomplished with such utterly inadequate appropriations, and urged that the next succeeding one be not less than $100,000. Only one-tenth of that sum was appropriated, and so it continued with mere pittances compared with what was requisite, the work dragging along from year to year without substantial advance toward the desired end. To go further into the history of operations would be only to repeat the story told in each report from the beginning, the sum total of which is that $100,000 has been expended in driblets, and that all there is to show for it are 2,570 feet of pier work and revetment, most all of which is in a condition of wreck and ruin, covering a channelway 370 feet wide, through which a depth of only from 5 to 7 feet can be kept, except by constant dredging.

No work was done during the year just ended until April 28, 1894, when, responding to appeals for relief to the little local commerce that seeks the harbor, the United States dredge *Saginaw* commenced dredging at the entrance where the available depth was only 5½ feet. Work was continued until May 26, when a channel 40 feet wide and 15 feet deep had been dredged between the piers, the amount of excavation being 24,870 cubic yards. An inspection of the harbor made a month later, June 9, showed that the newly dredged channel had already shoaled to 11 feet.

The zero of the water gauge at the harbor has been lowered 0.09 feet in compliance with instructions from the Chief of Engineers, dated December 4, 1893, so as to place its zero 3.06 feet below high water of 1838, the new plane of reference established for harbors on Lakes Michigan and Huron.

It must be evident to anybody who examines into the history and conditions of this work that a radical change from the course thus far pursued is mandatory, if any useful purpose is to be accomplished and further waste of money avoided. In considering this matter it is important to recognize the fact that the local commerce is utterly insignificant. No record is accessible to show just what it is, all requests concerning it remain unanswered, and those interested in it realize and admit that no exhibit can be made that would justify expenditures by the Government for improving the harbor on account of it. It follows from this that there can be no sufficient reason for further expenditure at this place unless it be in the necessity for a harbor of refuge.

The existence of such condition was fully admitted sixteen years ago, and certainly it is no less so now than then, not only because of the increase in general lake commerce, but the commercial importance of neighboring harbors has grown in the same or greater proportion, and the vessels frequenting them are of vastly greater tonnage and value. These harbors were not designed as places of refuge, and when shelter is needed they can be entered only with the risk of disaster on account of the limited width of opening between piers.

It would therefore appear that while a harbor of refuge at Portage Lake is highly desirable for the security of general commerce on Lake Michigan, it would be of special moment to that of neighboring harbors such as Frankfort, Manistee, and Ludington, with their railway terminals and connecting water lines.

The estimate submitted for 1896 is substantially the same as that contained in the last annual report, and the appropriation of the full amount is urgently recommended if any real effort is to be made to secure a harbor of refuge at this place. If this is not done the work had better be abandoned, for no effective advance in that direction can be made with a sum materially less, and there appears to be no reason for further appropriations by the Government with any other object in view. The estimate is as follows: 600 feet new crib work for extending the piers, $60,000; rebuilding 1,240 linear feet of old north pier and revetment, $38,000; sheet piling and refilling south pier and revetments, $6,000; dredging, $10,000; making, with contingencies, $125,000.

There is a fourth-order light near the end of the north pier, maintained by the Light-House Establishment.

The harbor is included in the Michigan collection district; the nearest port of entry is Grand Haven, Mich.

Appropriations for harbor of refuge at Portage Lake, Michigan.

March 3, 1879	$10,000	August 5, 1886	$15,000
June 14, 1880	10,000	August 11, 1888	10,000
March 3, 1881	10,000	September 19, 1890	8,000
August 2, 1882	25,000		
July 5, 1884	12,500	Total	100,500

Original estimated cost of work, 1879, as amended in 1890	$267,500.00
Whole amount appropriated from 1879 to and including act of September 19, 1890	100,500.00
Whole amount expended to June 30, 1894	98,320.13

Money statement.

July 1, 1893, balance unexpended	$3,885.39
June 30, 1894, amount expended during fiscal year	1,705.52
July 1, 1894, balance unexpended	2,179.87
July 1, 1894, outstanding liabilities	105.27
July 1, 1894, balance available	2,074.60
Amount (estimated) required for completion of existing project	167,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	125,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

L L 14.

IMPROVEMENT OF FRANKFORT HARBOR, MICHIGAN.

The harbor works at this place comprise a dredged channel, with lateral revetments of pile work, and crib piers in extension thereof, whereby entrance from Lake Michigan is had to the inland lake, Aux Becs Scies (Frankfort), which constitutes the harbor. These works were begun by the Government with the appropriation of $88,541 made by the river and harbor act of June 23, 1866, but before that time local enterprise had improved an outlet from the interior lake 750 feet north of the present entrance and protected it by slab piers, 80 feet apart, extending 600 feet into Lake Michigan, thereby providing a channel from 3 to 4 feet deep between the two lakes. The Government project provided for a channel 12 feet deep and 250 feet wide, at an estimated cost of $146,400. The necessity for subsequent pier extension, to keep pace with the accumulation of sand where these structures are erected, and the cost of repairs and periodical dredging, have caused this estimate to be revised and increased from time to time, until the revision of 1892, in accordance with which operations are now being carried out, placed the total cost of work done and proposed at $325,659.85.

No progress toward completing the project was made during the past year, because there was too little money available to admit of any pier extension, and all that could be done was to make the necessary repairs of old structures and maintain the requisite channel between piers by dredging, and also by placing sheet piling and sand fences to prevent sand in rear of the piers from getting into the channel. For this purpose 325 linear feet of double sheet piling were driven along the rear of the north revetment, making it sand tight; the old sand fences on the north beach were repaired, and 365 linear feet of new sand fences, 5 feet high, were built.

The repair work on piers comprised removing the old superstructure of north revetment for a length of 64 feet, sawing off piles at water surface, and building new superstructure five courses high; about 300 linear feet of rotten timbers were removed from the piers and replaced by new ones; for protecting the east end of revetment from damage by the large lake-ferry steamers, operated in connection with the Toledo, Ann Arbor and North Michigan Railway, a cluster of five piles was driven at the inner end of both piers; plank walks 3 feet wide were laid on both piers, that on the north being 900 feet long, and on the south 1,117 feet. A large amount of drift that had accumulated in the uncovered south pier was removed.

Between August 30 and September 11 the United States dredge *Saginaw* excavated 6,933 cubic yards, for improving the channel between piers and through a shoal that overlaps the north and reaches nearly to the south pier. The gales of early October caused very considerable deposits of sand on this shoal, reducing the depth of water to 8.3 feet at one point to 10 feet about midway between piers, and obliterating the newly-dredged channel. The large car ferryboats could no longer pass the shoal until they had scoured a new channel through it with their propeller wheels, and in connection with this work they managed to do considerable damage to the harbor piers.

The condition of the harbor June 30, 1894, was as follows:

The north pier and revetment had a total length of 1,098 feet, of which 396 feet is pile revetment and 702 feet crib work, the outer end of which is only 428 feet beyond shore line. The south pier's total length is 1,337 feet, 187 being pile revetment and 1,150 crib work, the outer end of which is 867 feet beyond the shore line. The width of channelway between piers is 200 feet. The piers are in fair condition, but some considerable stone is required to fill them as they should be for their preservation, and parts of the old superstructure need quite extensive repairs. The available depth of channel through shoal at entrance was 15 feet, but it is liable to be obliterated by the first hard storm that visits this locality. The navigable depth inside of this shoal is 16 feet until Frankfort Lake is reached, where there is plenty of water at all times.

It is important that the piers be extended in accordance with the present approved project, as it is impossible to maintain a 12-foot channel at the entrance as matters are now.

The estimate for 1896 is as follows: Four hundred linear feet of crib work for extending piers, $40,000; sheet piling, repairing and refilling piers, $5,000; dredging and contingencies, $6,000; total, $51,000.

A sixth-order light is maintained by the Light-House Establishment near the west end of the south pier, and the Life-Saving Service has a station at its east end.

The harbor is in the collection district of Michigan, and the nearest port of entry is Grand Haven, Mich.

Appropriations for improving harbor at Frankfort, Mich.

Aux Becs Scies:	
June 23, 1866	$88,541.00
March 2, 1867	10,000.00
July 25, 1868	10,000.00
April 10, 1869	29,318.85
July 11, 1870	10,000.00
March 3, 1871	10,000.00
Frankfort, Mich.:	
June 10, 1872	10,000.00
March 3, 1873	10,000.00
June 23, 1874	10,000.00
March 3, 1875	10,000.00
August 14, 1876	3,000.00
Frankfort, Mich.—Continued.	
June 18, 1878	$8,800.00
March 3, 1879	4,000.00
June 14, 1880	5,000.00
March 3, 1881	10,000.00
August 2, 1882	15,000.00
July 5, 1884	5,000.00
August 5, 1886	7,000.00
August 11, 1888	8,000.00
September 19, 1890	10,000.00
July 13, 1892	10,000.00
Total	283,659.85

Original estimated cost of the work in 1866, amended in 1868, 1879, and 1892	$325, 659. 85
Whole amount appropriated to June 30, 1894	283, 659. 85
Amount covered into Treasury, Report 1871, p. 133	5, 721. 50
Whole amount expended to June 30, 1894	273, 909. 83

Money statement.

July 1, 1893, balance unexpended	$7, 831. 13
June 30, 1894, amount expended during fiscal year	3, 802. 61
July 1, 1894, balance unexpended	4, 028. 52
July 1, 1894, outstanding liabilities	420. 77
July 1, 1894, balance available	3, 607. 75
Amount that can be profitably expended in fiscal year ending June 30, 1896	51, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, FRANKFORT HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year:			
1884	488	$404. 70	
1885	261	75. 66	
1886, 1887, 1888*			
Calendar year:			
1888	1, 342		216, 376
1889 *			
1890	443		27, 140
1891	1, 541		258, 908
1892	910		167, 777
1893	988		278, 709

* Not stated.

Receipts and shipments by vessel, 1893

[Compiled from statements furnished by the collector of customs; W. H. Chambers, village president; and H. W. Ashley, general manager Toledo, Ann Arbor and North Michigan Railroad.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED—continued.		
Coal		6, 695	Coal		19, 456
Fish ....barrels	1, 267	190	Fish		209
Flour ....do	431, 755	42, 312	Fruit, miscellaneous		144
Fruit, miscellaneous		30	Iron and ore		75
Grain		8, 667	Lime, cement, and brick		1, 789
Hay and feed		4, 326	Lumber....M feet, B. M	38, 780	67, 865
Lime and cement		69	Machinery		330
Live stock		33	Merchandise, general		4, 406
Lumber........feet, B. M	6, 808, 571	11, 915	Mineral water, bottles	100, 400	100
Merchandise, general		190	Miscellaneous		10, 863
Miscellaneous		17, 156	Potatoes		349
Stone ....cords	100	625	Salt ....barrels	15, 508	2, 171
			Shingles ....M	2, 300	288
Total		92, 208	Slabs ....cords	9, 543	25, 552
			Tan bark ....do	5, 339	5, 339
SHIPPED.			Wood ....do	4, 254	6, 786
Cedar posts ......number	4, 100	82	Total		145, 804

In addition to classified tonnage, the car ferries between Frankfort, Mich., and Kewaunee, Wis., carried 7,769 freight cars, average weight, 27,000 pounds, making 104,881 tons.

L L 15.

IMPROVEMENT OF CHARLEVOIX HARBOR, MICHIGAN.

The present commercial harbor at this place has been made by establishing a navigable channel from Lake Michigan to Round Lake. The natural outlet from the latter before any improvement was a narrow stream about one-third of a mile long through which boats drawing 2 or 3 feet might pass; local enterprise, aided by State land grant, improved these conditions by dredging the river to a depth of 11 feet and building short piers at its outlet into Lake Michigan, thereby obtaining an available depth at entrance of about 6 feet. At this point the work of improvement by the General Government was inaugurated with an appropriation of $10,000 in the river and harbor act of August 14, 1876. The project of improvement, submitted October 30, 1875, was the basis of operations, and the estimated cost of its completion was $186,000. It provided for dredging a straight channel 12 feet deep through Pine River, protecting its sides by pile revetments, and its entrance by crib piers extending to 12 feet of water in Lake Michigan, with a channel way 150 wide between them. In 1882 this project was extended to provide a revetted channel 12 feet deep from Round Lake to Pine Lake, distant only about 375 feet, thereby opening this large body of water to commerce.

The harbor works in existence June 30, 1893, comprised 771 feet of crib work in north pier, with 953 feet of plank beam revetment extending from its shore end to near Round Lake, 491 feet of crib work in south pier, and 1,538 feet plank beam revetment from the pier to Round Lake; the width of channel is 150 feet between piers and narrows to 100 feet as Round Lake is approached. The channel connecting Round and Pine lakes is 83 feet wide between revetments, the length of the latter being 339 feet on the north and 366 feet on the south side. The available depths of water at that time were 13 feet from Lake Michigan to Round Lake, and 12½ feet from the latter to Pine Lake.

Operations during the past year were limited to repairs at piers and revetments, placing decking on south revetment of upper channel into Pine Lake, and dredging. The principal item of repairs was the substantial rebuilding of 400 linear feet of the south revetment, lower channel. The piling of this section had yielded to pressure, and was in danger of failing completely at any moment. The conditions were such that most of the old piling had to be pulled out, new piles driven and surmounted by a new superstructure four courses high of 12 by 12 inch timbers. The new revetment is a substantial structure of piling penetrating the river bed from 12 to 15 feet, backed by a double row of sand-tight sheet piling, all connected by iron tie-rods and wooden ties to a rear row of anchor piles. The work was done by contract, at a cost of $4,364.52, including everything required for removing the old structure. Other minor repairs consisted in removing rotten timbers at scattering points along the old revetment and piers and replacing them by new ones, closing openings in piers below water so as to prevent stone filling from passing out, and overhauling the filling so as to equalize it, and adding 63 cords of bowlders picked from the lake shore to supply deficiencies. Soundings made in April last showed a reduction in channel depths to 11½ feet in some places, and the United States dredge *Saginaw* was there to restore the requisite navigable conditions; working from June 2 to June 22, a channel by which vessels drawing 13 feet can pass from Lake Michigan to Pine Lake was obtained, the amount dredged being 16,945 cubic yards.

Such was the navigable condition of the harbor June 30, 1894. The extent of piers and revetments remained at that date the same as stated elsewhere in this report for June 30, 1893.

The approved project calls for a channel 12 feet deep, and this requires that the piers shall extend to at least that depth in Lake Michigan; the north pier fulfills that condition, but the south pier must be prolonged 200 feet to do so, and it should be done as soon as possible. Another matter calling for action at the earliest opportunity is the reconstruction of 500 feet of the north pier, commencing at the shore end, being that portion built on the old crib structures erected by the local authorities; it is constantly being undermined, and has settled so irregularly that the old timber work is tearing apart to such an extent that a complete breach of the pier may be looked for with every recurring northerly gale. Safety and economy require that further attempts to maintain it by constant repair be abandoned as soon as an appropriation for its removal and reconstruction can be obtained. The old plank beam revetment of the lower channel to Round Lake is rapidly deteriorating, and will require many scattering repairs until it can be remodeled and entirely rebuilt above water, as was done for the 400 feet before referred to in this report. The total remaining length requiring this treatment is 2,100 feet. Provision must be made for periodical dredging to maintain the requisite navigable depth.

The estimate for 1896 is therefore as follows: 200 linear feet new crib work for extending south pier to 12-foot curve, $20,000; removing 500 linear feet of old north pier crib work, and rebuilding it, $22,500; minor repairs of piers and revetments and dredging, $6,000; making, with 10 per cent, approximately, for contingencies, a total of $53,000.

The work is in the collection district of Michigan, the nearest port of entry being Grand Haven, Mich.

The Light-House Establishment maintain a fifth-order light near the end of the north pier.

Appropriations for improving harbor at Charlevoix, Mich.

August 14, 1876	$10,000	August 5, 1886	$10,000
June 18, 1878	12,000	August 11, 1888	12,500
March 3, 1879	9,000	September 19, 1890	9,000
June 14, 1880	10,000	July 13, 1892	10,000
March 3, 1881	10,000		
August 2, 1882	10,000	Total	112,500
July 5, 1884	10,000		

Original estimated cost of work, 1868, amended in 1876 and 1884	$186,000.00
Whole amount appropriated from 1868 to and including act of July 13, 1892	112,500.00
Whole amount expended to June 30, 1894	108,791.43

Money statement.

July 1, 1893, balance unexpended	$10,432.09
June 30, 1894, amount expended during fiscal year	6,723.52
July 1, 1894, balance unexpended	3,708.57
July 1, 1894, outstanding liabilities	868.47
July 1, 1894, balance available	2,840.10
Amount (estimated) required for completion of existing project	73,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	53,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, CHARLEVOIX HARBOR, MICHIGAN

Entrances and clearances.

Year.	Number.	Revenue collected.	Tonnage.
Fiscal year:			
1884	772	$355.46	....
1885	599	779.53	....
1886	674	390.46	....
1887	753	....	151,369
Calendar year:			
1888	526	....	92,306
1889	473	....	....
1890	532	....	75,224
1891	534	....	79,613
1892	537	....	79,966
1893	820	....	144,976

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by the collector and deputy collector of customs.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED—continued.		
Beer ....barrels..	500	91	Fishing supplies	....	34
Coal	....	9,761	Flour ....barrels..	2,500	250
Flour ....barrels..	300	30	Grain ....bushels..	10,000	280
Fishing supplies	....	40	Hay and feed	....	550
Grain ....bushels..	101,720	2,797	Iron and ore	....	610
Hay and feed	....	255	Lath ....M..	640	200
Iron and ore	....	4	Lime ....barrels..	2,000	220
Kerosene ....barrels..	1,600	400	Lumber ....M. feet, B. M..	27,126	47,475
Live stock ....heads..	50	25	Mattresses ......number..	10,400	208
Merchandise	....	18,000	Merchandise (general),		
Miscellaneous	....	384	packages	6,700	335
Salt ....barrels..	315	44	Miscellaneous	....	150
			Pig iron	....	25,000
Total	....	31,831	Posts ....number..	195,000	3,900
			Potatoes ....bushels..	12,500	375
SHIPPED.			Shingles ....M..	5,250	656
			Ties ....M..	246	22,140
Apples ....barrels..	2,000	200	Wood and slabs....cords..	14,138	28,276
Bark ....cords..	18,000	18,000			
Bricks ....M..	60	150	Total	....	149,409
Fish	....	400			

L L 16.

IMPROVEMENT OF PETOSKEY HARBOR, MICHIGAN.

Two appropriations, aggregating $35,000, have been made for improving this harbor, and two plans of improvement have been presented, but the question as to which will finally be adopted remains to be determined by Congress. The status is fully set forth in the last annual report, and its repetition is believed to be unnecessary in this one.

The cost of the smaller project is estimated at $70,000; that of the larger $170,000.

It is impossible to submit an estimate for 1896 until action on the river and harbor bill now pending in Congress shall have been taken, because the project to be followed and the sum available for its prosecution are dependent upon that action. But a due regard for economy of construction and the local interests at stake would urge that the appropriation for 1896 be sufficient, when taken in connection with previous appropriations, to complete the work. If the larger project be adopted, the appropriation should therefore be $135,000, less the amount that may be appropriated in the meantime.

The harbor is in the collection district of Michigan; the nearest port of entry being Grand Haven, Mich.

The nearest light-house is at Harbor Point, 4 miles distant.

Appropriations for improving harbor at Petoskey, Mich.

September 19, 1890	$15,000.00
July 13, 1892	20,000.00
Total	35,000.00
Original estimated cost of landing pier project	70,000.00
Original estimated cost of breakwater project	170,000.00
Total expenditures to June 30, 1894	223.22

Money statement.

July 1, 1893, balance unexpended	$34,780.80
June 30, 1894, amount expended during fiscal year	4.02
July 1, 1894, balance unexpended	34,776.78
Amount that can be profitably expended in fiscal year ending June 30, 1896	135,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, PETOSKEY HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Tonnage.
Calendar year 1893	1,338	8,000

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by Col. Isaac D. Toll, of Petoskey, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Apples and pears .barrels..	1,000	25	Brick ....M..	90	225
Brick ....M..	75	188	Cedar posts .....number..	4,750	95
Cedar posts ....number..	4,750	95	Fish	....	150
Fruit, miscellaneous, packages	4,000	135	Flour ....barrels..	3,000	300
Hay and feed ....bales..	6,000	300	Fruit, miscellaneous, packages	1,000	15
Hoops	....	200	Grain ....bushels..	3,000	83
Laths ....M..	100	30	Laths ....M..	25	8
Live stock ....heads..	300	53	Leather	....	10
Lumber .....M. feet, B. M..	1,000	1,750	Lime and cement .barrels..	10,000	1,300
Machinery	....	25	Live stock ....heads..	100	17
Merchandise (general)	....	6,000	Lumber ....M. feet, B. M..	1,000	1,750
Miscellaneous	....	2,500	Potatoes ....bushels..	10,000	300
Paper	....	60	Shingles ....M..	75	9
Pease ....bushels..	3,000	90	Slabs ....cords..	200	538
Salt ....barrels..	3,000	420	Tan bark ....do....	500	500
Slabs ....cords..	200	538			
Tan bark ....do....	100	100	Total	....	5,300
Total	....	12,509			

MEMORANDA RELATING TO DREDGING OPERATIONS ON EAST SHORE OF LAKE MICHIGAN DURING THE CALENDAR YEAR 1893.

The dredging plant, comprising three dredges, with attendant tugs and scows, as fully described in the last annual report, worked at 11 different harbors from Michigan City, Ind., to Frankfort, Mich., covering a coast line of 250 miles, with results as summarized in the three accompanying tables. These operations were in progress from April 1 to November 28, 1893, and comprised a total excavation of 308,280 cubic yards, at a cost of little less than 11⅓ cents per cubic yard, including operating expenses and repairs of plant. This is 2 cents higher than the cost of the previous season's work, and is accounted for by the increased cost of repairs to the two old machines, which have been in service over twenty-five years, and will soon have to be rebuilt. It is safe to say that the same work done by contract would have cost 50 per cent more, and lacked the highly important advantage attendant upon the presence of a plant available for transfer at a moment's notice to points where most needed.

Table 1 shows details relating to the amount, character, and cost of work done at each harbor, with the name of dredge engaged and time employed.

Table 2 shows details relating to operations of each dredge, including the number of days in commission, the actual working time as determined by deducting time occupied in moving from harbor to harbor and delays due to rough weather and repairs, and amount and cost of work.

Table 3 distributes the total cost under the four heads of Service, Supplies, Repairs, and Miscellaneous. It is seen that the repair account for the old dredges *Michigan City* and *Farquhar* amounts to a little over 30 per cent of their total operating expenses, while that of the *Saginaw* is less than 20 per cent. The hull of the *Michigan City* is in especially bad condition—was recently reported in a sinking condition—and will not outlast the present working season.

TABLE 1.—*General schedule of dredging by Government plant in 1893 at harbors on east shore of Lake Michigan.*

Harbor.	Dredge.	Dates.	Dimensions of cut.			Bottom of cut below zero of gauge.	Material dredged.	Total dredged.	Total cost.	Cost per cubic yard.
			Length.	Width.	Depth.					
			Feet.	*Feet.*	*Feet.*	*Feet.*		*Cub. yds.*		*Cents.*
Michigan City	Michigan City	Apr. 24–May 21 Nov. 21–Dec. 9	2,780	25 to 30	1 to 7.1	16 to 17.5	Sand, muck, and hardpan	9,522		
		May 22–June 8	1,158	20 to 30	3.5 to 15	7.8 to 17	Sand and muck	8,389		
								17,911	3,886.68	21.699
St. Joseph	Saginaw	Apr. 1–20 Apr. 28–May 11	2,920	40	4 to 15	13 to 21	Sand and silt	23,777		
	Michigan City	Oct. 3–Nov. 20	2,885	25	3 to 9.8	14 to 18	Sand and clay	18,285		
								42,062	5,469.55	13.003
South Haven	Farquhar	May 1–June 8	3,660	25	2 to 11	10 to 18	Sand and logs	15,090		
	Michigan City	July 29–Sept. 1	3,075	25 to 30	2.3 to 7.6	15 to 17	Sand	17,815		
		Sept. 19–Oct. 2	1,175	25	3.5 to 5.5	15 to 17	Sand	6,050		
								39,555	3,988.89	10.084
Saugatuck	Michigan City	June 9–July 28	5,425	25	1.8 to 5.6	10 to 13	Sand	23,880.5		
		Sept. 2–18	835	25	2.1 to 6.2	10 to 13	Sand	4,525		
								28,405.5	2,761.39	9.721
Black Lake	Farquhar	Apr. 5 to 30	1,720	25	2 to 9	14 to 16.5	Sand and logs	8,765		
		June 9–30	1,155	25	4 to 7	16.5 to 18	Sand	6,822		
								15,587	2,539.05	16.289
Muskegon	do	Aug. 13–Nov. 28	9,788	25	1 to 10	18.3 to 19.2	Sand	33,416	4,620.56	13.824
White River	do	July 1–Aug. 12	3,485	25	2 to 5.5	16	Sand and clay	14,216	1,849.98	13.013
Pentwater	Saginaw	July 23–Aug. 23	2,240	35	2 to 7	16.5	Sand, slabs, and wood	19,436.5	1,369.42	7.045
Ludington	do	June 24–July 22	2,455	40	3 to 6.25	20	Sand and clay	18,660	1,907.94	10.224
Manistee	do	May 12–June 23	3,675	20 to 40	3 to 7.5	19	Sand	26,300		
		Sept. 17–Nov. 26	5,285	35	2 to 7	19 to 21	Sand	45,798		
								72,098	5,341.22	7.408
Frankfort	do	Aug. 24–Sept. 11	1,510	40	1.5 to 7	18.5 to 20.5	Sand and gravel	6,933	1,153.13	16.632
Grand total of amount and cost and average cost								308,280	34,887.81	11.3168

TABLE 2.—*Schedule of dredging operations for the season of 1893—work and cost of each dredge.*

Dredge.	Commission.	Worked.	Total dredged.	Total cost.	Average cost per cubic yard.
	Days.	*Days.*	*Yards.*		*Cents.*
Michigan City	182½	118 15/16	88,466.5	$11,247.14	12.713
Farquhar	211¾	166 1/16	78,909	11,783.55	14.933
Saginaw	196⅝	149½	140,904.5	11,855.12	8.413
Total	590⅞	434½	308,280	34,885.81	11.316

Average product per working day.

	Cubic yards.
Michigan City	660
Farquhar	475
Saginaw	940

TABLE 3.—*Distribution of cost of dredging, 1893.*

Dredge.	Services.	Supplies.	Repairs.	Miscellaneous.	Total.
Michigan City	$5,078.92	$1,990.50	$3,977.91	$199.81	$11,247.14
Farquhar	5,974.30	1,976.70	3,236.35	596.20	11,783.55
Saginaw	6,351.91	2,804.89	2,227.85	470.47	11,855.12
Total	17,405.13	6,772.09	9,442.11	1,265.48	34,885.81

L L 17.

IMPROVEMEMT OF CHEBOYGAN HARBOR, MICHIGAN.

This harbor is at the mouth of the Cheboygan River, where there was a navigable depth of 6 feet in 1870, when the first survey and project for improvement were made. This project was for dredging an entrance channel 200 feet wide by 14 feet deep and protecting its sides by pile revetments and piers aggregating 4,600 feet in length. Its estimated cost was $395,335.

The first appropriation for the work was made in the river and harbor act of March 3,1871, and it was applied to dredging. Subsequent appropriations were applied on the same, for it began to appear soon after operations had been commenced that the proposed revetments and piers might not be requisite for maintaining the dredged channel. Dredging was carried to a depth of only 13 feet until 1880, when it was increased to 15 feet for a width of 50 feet in mid-channel; in 1882 it was decided to extend this depth over the entire width of dredged channel, and in 1888 to prolong the channel up to the State road bridge. The final contract, under which work authorized by the approved project was completed, was closed November 29, 1889. A 15-foot channel, 200 feet wide, was thereby secured from deep water in the Straits of Mackinac to the State road bridge over the Cheboygan River, a distance of about 7,100 feet. Entrance to the channel is marked by a crib 40 feet square, which was built for that purpose in 1881, and now serves also as the foundation for a light-house, maintained by the U. S. Light-House Establishment.

No work has been done since 1889, and the channel depth has become reduced to a navigable capacity of scant 13 feet, as shown by recent soundings, though a very considerable portion of the dredged area is still from 14 to 15 feet deep. It is important that the full depth of 15 feet be restored, and it is proposed to do so with the unexpended balance of appropriation. No estimate for further appropriation is submitted at this time, as there is at present no approved project for any additional work; but it is quite certain that the interests of commerce will soon require that means be provided for increasing the depth to 18 feet.

Cheboygan is in the Michigan collection district of Michigan. The nearest port of entry is Grand Haven, Mich., and the nearest light-house is on the crib at entrance to the harbor.

Appropriations for improving harbor at Cheboygan, Mich.

March 3, 1871	$10,000	June 14, 1880	$6,000
June 10, 1872	15,000	March 3, 1881	6,000
March 3, 1873	15,000	August 2, 1882	10,000
June 23, 1874	15,000	July 5, 1884	5,000
March 3, 1875	15,000	August 5, 1886	15,000
August 14, 1876	10,000	August 11, 1888	15,000
June 18, 1878	8,000		
March 3, 1879	3,000	Total	148,000

Original estimated cost of dredging and pier construction, 1871	$395,000.00
Whole amount appropriated, 1871, to and including act of August 11, 1888	148,000.00
Whole amount expended to June 30, 1894	129,828.24

Money statement.

July 1, 1893, balance unexpended	$18,197.68
June 30, 1894, amount expended during fiscal year	25.92
July 1, 1894, balance unexpended	18,171.76
July 1, 1894, outstanding liabilities	158.67
July 1, 1894, balance available	18,013.09

COMMERCIAL STATISTICS, CHEBOYGAN HARBOR, MICHIGAN.

Entrances and clearances.

Year.	Number.	Tonnage.
1887	1,587	405,921
1889	1,496	453,456
1891	1,384	367,550
1892	1,384	345,174
1893	1,240	308,129

In addition to the above, eight steamers, with an aggregate tonnage of 4,000 tons, trade regularly at this port, but are not entered or cleared at the custom-house.

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by the deputy collector of customs.]

Articles.	Tons.
RECEIVED.	
Brick	100,000
Coal	6,989
Fruit, miscellaneous	125
Grain	40
Hay and feed	660
Lime and cement	2,500
Lumber	39,000
Machinery	304
Merchandise (general)	6,100
Oil	180
Total	155,898
SHIPPED.	
Beer	70
Fish	1,600
SHIPPED—continued.	
Flour	328
Hay	98
Laths	6,300
Live stock	20
Lumber	140,115
Merchandise (general)	600
Posts	3,437
Potatoes	300
Salt	1,700
Shingles	1,400
Slabs	3,500
Tan bark	691
Telegraph poles	30
Ties	126,000
Total	285,189

L L 18.

IMPROVEMENT OF ALPENA HARBOR (UNDER APPROPRIATIONS FOR THUNDER BAY HARBOR AND THUNDER BAY RIVER), MICHIGAN.

The city of Alpena occupies both banks of Thunder Bay River at its mouth, and this reach of river, about a mile long, constitutes the harbor of Alpena. This harbor, with the entrance channel through the bar in advance of it, has been the subject of improvement by the Government since 1876, the appropiations for which have been in the name of Thunder Bay Harbor or Thunder Bay River.

The original depth of water over the bar at the river's mouth was only 7 feet, but when surveyed in 1871 this depth had been increased by local enterprise to 12 feet, and it was reported as sufficient for commercial needs. In 1876 report of a second survey was made, with recommendation that the still existing 12-foot channel be deepened to 13 feet and made 200 feet wide, at an estimated cost of $4,764. Congress appropriated $4,500 for the work in the river and harbor act of August 14, 1876, and the improvement was accomplished in the year following, at a cost of $3,935.36. In 1881 the channel had shoaled to such an extent that its restoration was a necessity, and an estimate of $15,000 for redredging it to a depth of 14 feet was followed by the appropriation of that amount in 1882. The work was completed in the following year, its cost being $4,500 less than the estimate. In 1888 the increased requirements of commerce led to a recommendation that the depth be incressed to 16 feet, and in 1889 it was further recommended that this depth be made all the way upstream to the head of navigation at the milldam, about a mile above the mouth, all at an estimated cost of $36,087.48. Operations since then have been directed to the achievement of that project, and by June 30, 1893, it was nearly completed, work on the final contract being then in progress.

During the past fiscal year operations were in progress to August 3, 1893, only, when the work of dredging under the contract made with H. W. Hubbell & Co., October 1, 1892, was finished. The amount excavated from July 1 to August 3, when the contract was closed, was 9,306 cubic yards. Alpena Harbor then had a continuous 16-foot channel from the bay to and along the city front, a total length of 7,000 feet, of which 1,700 feet was in open cut through the bar in advance of the harbor proper. The width of this cut was 200 feet at its outside end and 150 feet at its inner end. From this point the channel way is between the city docks and piers, and, conforming to the distance between the north and south dock lines, has a width of 100 feet for a distance of 3,000 feet, 75 feet through the next stretch of 1,500 feet, and then 50 feet to the head of navigation.

Soundings taken in the channel June 15, 1894, from the entrance to the first bridge over the river 2,400 feet above, showed that some filling has taken place, by which the depth has been reduced to 15½ or 15 feet, and at one place to 14 feet, but through most of the distance the full depth of 16 feet or more was found. Further shoaling is inevitable, and dredging will then be required to restore the channel, or, as is more likely, to still further deepen it to 18 feet, in order to meet the growing wants of commerce. The estimate of $5,000 submitted below is to provide means for doing only such dredging as may be found necessary for maintaining the depth of channel called for by the present approved project, and it is recommended that such appropriation be made in the name of improving "Alpena Harbor." Thunder Bay Harbor is another affair altogether, being the general anchorage and sheltered area in the northeastern portion of the bay, used as a natural harbor of refuge against all northerly winds, and in no need of improvement. The only portion of Thunder Bay River that can call for improvement is that now comprised in Alpena Harbor.

Alpena Harbor is in the collection district of Huron, Mich. The nearest port of entry is Port Huron, Mich., and the nearest light-house is at the mouth of Thunder Bay River.

Appropriations for improving harbor at Thunder Bay, Michigan.

August 14, 1876	$4,500.00
August 2, 1882	15,000.00
September 19, 1890	5,500.00
Improving Thunder Bay River, Michgan:	
September 19, 1890	10,000.00
July 13, 1892	10,000.00
Total	45,000.00
Original estimates of cost, 1876, 1881, and 1889, aggregate	55,851.48
Total appropriations to and including act of July 13, 1892	45,000.00
Total expenditures to June 30, 1894	40,189.17

Money statements.

THUNDER BAY (ALPENA) HARBOR, MICHIGAN.

July 1, 1893, balance unexpended	$823.63
June 30, 1894, amount expended during fiscal year	823.63

THUNDER BAY RIVER (ALPENA HARBOR), MICHIGAN.

July 1, 1893, balance unexpended	$9,441.03
June 30, 1894, amount expended during fiscal year	4,630.20
July 1, 1894, balance unexpended	4,810.83
July 1, 1894, outstanding liabilities	158.67
July 1, 1894, balance available	4,652.16
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	5,000.00

COMMERCIAL STATISTICS, THUNDER BAY RIVER (ALPENA HARBOR), MICHIGAN.

Entrances and clearances.

Year.	Number.	Tonnage.
Calendar year 1893	940	247, 278

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by the deputy collector of customs.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Apples and pears . barrels	2, 000	200	Fish		450
Brick		2, 000	Hay and feed		900
Coal		10, 000	Lath . M	5, 500	1, 650
Flour . barrels	12, 000	1, 200	Lumber . M feet, B. M	144, 841	253, 471
Fruit, miscellaneous	10, 000	400	Posts . number	498, 540	9, 971
Grain . bushels	1, 200, 000	33, 300	Potatoes . bushels	4, 000	120
Live stock		500	Shingles . M	12, 678	1, 585
Stone		500	Staves . M	2, 121	1, 010
Sulphite fiber		3, 000	Telegraph poles . number	14, 378	2, 155
Sulphur		500	Ties . do	527, 459	37, 676
Total		51, 600	Total		308, 988

L L 19.

IMPROVEMENT OF SAGINAW RIVER, MICHIGAN.

The improvement of this river was commenced in 1867 under a project for dredging a channel 12 feet deep through the bar at its mouth, in Saginaw Bay, and this channel was completed with a width of 195 feet in 1869 at a cost of $103,394. The navigable capacity of natural channel before improvement was only 8 feet. Nothing further was done until 1873, when a partial survey of the upper portions of the river was made, and an estimate of $56,000 submitted for local improvements. A series of operations were then commenced whose object was to obtain navigable channels 10 feet deep through the worst bars and shoals, projects for which were submitted from time to time, with estimates of cost, in which the controlling element was to obtain, with the funds appropriated, the improvements most urgently needed. The total expenditures under these projects aggregated about $115,000. In 1882 a radical and comprehensive scheme of improvement for the entire river, having reference to the then existing commercial requirements, was reported by a board of engineers. Its report has been the basis of all subsequent work, and the project submitted therein is that under which operations are still being conducted. Its purpose is to obtain a channel 200 feet wide and 14 feet deep from Saginaw Bay to and along the front of Bay City, and thence a channel of the same width, 12 feet deep, to the head of navigation. The estimated cost was $446,000.

The total expenditure for improving the river to June 30, 1893, was $654,873.98, of which $435,873.98 has been expended since the project of 1882 was adopted. As a result there was a channel 14 feet deep and generally 200 feet wide from Saginaw Bay to South Bay City, and from there up to the head of navigation channels 12 feet deep had been dredged through shoal places, affording less depth to a width of 50 feet or more. The total length of dredged channels was about 86,000 feet. In addition a channel 12 feet deep, from 50 to 75 feet wide and 15,000 feet long, was dredged through the west channel along West Bay City.

During the last fiscal year work under the two dredging contracts in force at its commencement was continued, as follows:

1. Contract of Edmund Hall, approved October 4, 1892, and supplemental contract to same, approved July 19, 1893, for dredging bar at mouth of river, at 29 cents per cubic yard.

2. Contract of Thomas M. Hubbell, approved October 7, 1892, for dredging channels above Bay City, at 37 cents per cubic yard.

Work on the bar, under the Hall contract, was continued until November 6, when the proposed work was completed and contract closed. The amount excavated from July 1 to November 6, 1893, was 73,797 cubic yards.

Work under the Hubbell contract was prosecuted as follows: (1) On the shoal below Melbourne; (2) shoal 2 miles above Melbourne, at New York Works; (3) east half of channel from Genesee avenue bridge to the Flint and Pere Marquette Railroad bridge, Saginaw; (4) west half of channel above Bristol street bridge, Saginaw; and (5) at Zilwaukee bar, 3 miles below Saginaw.

These operations were continued until November 22, 1893, when, ice forming and the money appropriated for work on this section being nearly exhausted, operations were suspended and contract closed. The total dredged under this contract in the fiscal year was 74,993 cubic yards.

The amount dredged under both contracts was 148,790 cubic yards, and the result was a wider channel at the places indicated, except at Zilwaukee Bar, where the work was done for removing deposits by which the channel formerly dredged had become obstructed.

In February, 1894, a careful survey of this bar was made, with soundings taken through the ice, in order to ascertain the full extent of deposits, and when this was completed like surveys were made at New York Works Bar, Essexville Bar, and bar at mouth of the river. The examinations establish the fact that all of these improved channels, except that at Essexville, have become materially impaired.

At Zilwaukee Bar the deposits are principally on the upper portion, just below the point at which the river is divided by Crow Island, so that a large portion of its waters pass into the Oneida Channel, so called. This effect appears to be due to the omission of a deflecting structure that was provided in the project for permanent improvement to hold the water in the navigable river channel. It seems that this omission was due to antagonism from the Saginaw Salt and Lumber Company, who protested that their interests would be seriously affected if the design was carried out. It was therefore concluded to defer the proposed work until it was shown that the improved channel could not be maintained without it. This fact seems now to be well established, and the interest of the company referred to should no longer suffice to prevent the work being done as soon as opportunity offers.

At New York Works Bar, located just below the Crow Island, where the Oneida Channel returns to the main river, the improved channel is also impaired; this too appears to be caused by the action of the Saginaw Salt and Lumber Company, which, claiming the exclusive use of the Oneida Channel as a log boom, has dredged along the east side of Crow Island and thrown the excavated material beside the cut thus made; being of sand and mud, a large part of this material has washed into the main channel and deposited at the head of the bar. The remedy is to redredge the channel, and prevent further work in the Oneida channel that may threaten its permanence.

The examination of the bar at the mouth reveals unmistakable evidence of a gradual deterioration in the dredged channel—the extent of shoaling in the several reaches being measurably proportional to the time elapsed since the dredging for their improvement was done. The shoaling is generally on the east side of the cut, and is in some places such that the foot of the slope on that side is now only 20 or 25 feet from the axis of channel; it appears to have resulted in part from the washing of its crest into the channel way, and partly from sewage and sand brought down by the river current. This filling will have to be dredged out in order to restore the channel to its full width; the amount to be dredged, as shown by the survey, is 85,585 cubic yards. The material is soft, and can be removed easily and cheaply. It is evident that periodical dredging will be necessary for the maintenance of this channel.

In relation to the amount required for completing the projected improvement of this river, I can at this time do no better than quote the following from the last Annual Report:

> The nominal "amount (estimated) required for completion of existing project," as given in the money statement on p. 2458 of the last Annual Report, is $68,250, although on p. 2457 it is computed that the amount of material yet to be removed in accordance with the prescription of the original project is about 640,000 cubic yards, which would cost about $281,000.
>
> The appropriation of $100,000 by the act of July 13, 1892, still leaves $181,000 of the actual amount computed as necessary to complete and largely exceeds the nominal amount of $68,250 given in the money statement. The discrepancy arises, doubtless, partly from the omission to make due corrections in the original estimates, to allow for varying price of material and work, additions and enlargements to the project, etc.; partly from the charging of maintenance, repair, and incidental expenses, such as redredging certain localities, repairing works, etc., as, for example, the $6,000 estimated as the cost of rebuilding the Carrollton training dike, after its partial destruction by fire in 1890. If, in fact, the estimate of $5,000 per annum as the average cost of maintaining an extensive and important navigation in opposition to the endeavor of natural forces of great magnitude and unremitting in action to thwart and obliterate its improvement, have any applicability to the case of the Saginaw, it would not be illogical to charge up that amount to the item of "maintenance" instead of "construction," with the result that for the twenty-seven years the Saginaw improvement has been in progress the sum of $135,000 might properly be omitted from the charges against the orignal estimate and stand as a credit at this time.
>
> However this may be, it is proper to state as an engineering fact that the sum of $150,000 can profitably be expended on continuing the improvement of the Saginaw in conformity with the approved project.

From a personal examination of the river made last month, I am satisfied that a new hydrographic survey is needed as a basis for any reliable estimate of cost of completing the improvement as contemplated by the present project. It is also my opinion that a revision of this project, having reference to the present condition of the river and its present commercial needs, both of which are different from what they were twelve or thirteen years ago, is desirable. There is no doubt, however, of the fact that an appropriation of $150,000 for 1896 can be profitably expended, and is necessary for reasonable progress on the extensive plan of improvement.

The work is all in the collection district of Huron, Mich.; nearest port of entry is Port Huron, Mich.; nearest light-house, at mouth of the river.

Appropriations for improving Saginaw River, Michigan.

June 23, 1866	$67,500	March 3, 1881	$10,000
March 2, 1867	28,000	August 2, 1882	125,000
July 25, 1868	9,000	July 5, 1884	50,000
July 11, 1870	1,500	August 5, 1886	33,750
June 23, 1874	15,000	August 11, 1888	65,000
March 3, 1875	30,000	September 19, 1890	75,000
August 14, 1876	11,000	July 13, 1892	100,000
June 18, 1878	25,000		
March 3, 1879	8,000	Total	668,750
June 14, 1880	15,000		

Estimated cost of successive projects, 1867 to 1882	$289,795.00
Estimated cost of project of 1882	446,000.00
Total	735,795.00
Total appropriated to June 30, 1894	668,750.00
Total expended to June 30, 1894	654,873.98
Carried to surplus fund	1,000.00

Money statement.

July 1, 1893, balance unexpended	$79,138.11
June 30, 1894, amount expended during fiscal year	66,262.09
July 1, 1894, balance unexpended	12,876.02
July 1, 1894, outstanding liabilities	502.61
July 1, 1894, balance available	12,373.41
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	150,000.00

COMMERCIAL STATISTICS, SAGINAW RIVER, MICHIGAN.

Entrances and clearances.

Year.	Number.	Tonnage.
Calendar year 1893	1,290	393,487

Receipts and shipments by vessel, 1893.

[Compiled from statements furnished by the deputy collectors of customs at Saginaw and Bay City, Mich.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			SHIPPED.		
Cedar posts ......number..	8,000	160	Cement ....bushels..	100,000	6,000
Coal		97,763	Gravel		550
Gravel........cubic yards..	6,000	7,800	Lath ....M..	51,627	15,488
Lime and cement		390	Lumber..... M feet B. M..	394,593	690,538
Merchandise, general		12,500	Merchandise, general		817
Lumber......M feet, B. M..	50,000	87,500	Miscellaneous		311
Potatoes..........bushel..	10,000	300	Salt.......... barrels..	670,106	93,815
Saw logs..... M feet, B. M..	170,000	425,000	Shingles ....M..	84,233	10,529
Stone ....cords..	2,200	13,750	Staves ....M..	100,500	251,250
Wood..........do..	4,000	6,000			
			Total		1,069,298
Total		651,163			

L L 20.

IMPROVEMENT OF HARBOR OF REFUGE AT SAND BEACH, LAKE HURON, MICHIGAN.

It is safe to say that no improvement of its kind on the shores of the Great Lakes has been of more value to their general commerce than this one. The site on the west shore of Lake Huron, 60 miles north of its outlet into the St. Clair River, was selected after careful consideration in 1872; work of construction commenced in the year following, and by 1885 the breakwater structures were completed. But long before this passing vessels had commenced to seek shelter behind the partly finished works, the record showing that 7,991 came in for refuge during the eight preceding years.

The harbor works comprise three separate piers, or breakwaters of crib work filled with stone, so located as to cover the sheltered area on the north, northeast, and east sides. The northerly one, called the west pier, starts in shallow water 750 feet from the shore line, and extends about east-southeast for a distance of 1,503 feet. The main pier commences 300 feet eastward of the end of the west pier, extends in a southeasterly direction 4,675 feet, and bears the brunt of the northeasterly gales; the south pier commences 600 feet south of the southerly end of the main pier, and extends 1,956 feet on a due north and south line. This arrangement provides an entrance 300 feet wide from the north, and one 600 feet wide from the east. There is an uncovered interval of 2,000 feet extending from the south end of the breakwater system to the shore line, but the depth of water is there so small that the seas raised by southeasterly gales are much broken on entrance, so that effective shelter can be found, when such storms prevail, in the northeasterly portion of the harbor. The original estimate of cost was $1,442,500, but the breakwater system as above described was completed at a cost of $975,000. Expenditures since that time have been for maintenance and repairs, and for dredging to provide more extensive accommodations within the piers, and increased depth at the north and east entrances.

The work of improvement and repairs carried on during the past fiscal years were those indicated in a special report made May 19, 1893, providing for placing a 10 by 12 inch oak wale on the entire length of harbor face of main pier, replacing about one-third of the 3-inch decking with new material 6 inches thick, tearing out exposed decayed timbers above water and replacing them with new. The work was done by hired labor, and material purchased under contract approved June 30, 1893, as follows:

Contract of Henry Howard, of Port Huron, Mich., 84,720 feet, B. M., white pine timber, at $22, $1,863.84, and 5,400 feet, B. M., pine plank, at $20, $108; total, $1,971.84.

Contract of H. M. Loud, of Oscoda, Mich., 252,754 feet, B. M., hemlock timber, at $12, $3,033.04.

Contract of Parkhurst & Wilkinson, of Chicago, Ill, 48,102 pounds drift bolts, at $2.14 per 100 pounds, $1,029.38.

Bids received in response to circular letter inviting proposals for oak timber were opened July 15, 1893, and contract made with the lowest bidder, F. S. Shurick, of Marietta, Ohio. The material furnished under this contract was 48,847 feet, B. M., oak timber, at $28,-$1,367.71.

In addition to the foregoing, 23,965 pounds of drift bolts were purchased in open market from the Michigan Bolt and Nut Works, of

Detroit, Mich., for $2.075 per 100 pounds, $497.27, and 54¼ cords of stone, for refilling crib work, were purchased in like manner from J. E. Tucker, of Sand Beach, Mich., at $5 per cord, $271.25.

The delivery of most of the foregoing material was completed by the early part of September, 1893, and its application to the proposed repairs was then commenced, and the work was completed November 21. In this work all the old waling plank and upright sheeting were removed from the harbor face of the main pier, and new 10 by 12 inch oak wale secured in place for a length of 4,138 feet; the old 3-inch decking was renewed with 6-inch hemlock plank for a length of 1,424 feet, and new 3 by 10 inch oak capping was put in place for the same distance; all decayed timbers that were accessible were taken out and replaced with new material. In addition to these general repairs, 330 linear feet of the sea wall, which had been carried away from the main pier by the storm of April 21, 1893, was rebuilt during the months of June and July following. The steamer *Wissahickon*, in making a landing July 26, ran into the pier and cut a hole from the top down to the water level, 6 feet wide; the damage was repaired during the following month. The south pier was slightly damaged by ice during the past winter, and the main pier by the storm of May 18–19. The necessary repairs of both piers were made during the month of May.

At the beginning of the year dredging had just commenced under a contract with Dunbar & Sullivan, of Buffalo, N. Y., dated March 27, and approved April 15, 1893, for the purpose of obtaining a clear depth of 21 feet at the north and east entrances and extending the area of like depth over adjoining portions of the harbor. These operations are intended to cover a total area of about 364,600 square yards, of which 161,800 is in the vicinity of the north and 202,800 of the east entrance. The amount dredged during the fiscal year was 70,160 cubic yards, resulting in deepening to 21 feet an area of 145,700 square yards, or a little more than 39 per cent of the total area for which dredging is at present authorized. The material dredged is largely rock and bowlders, and the contract price for the work is 43 cents per cubic yard. The cost of the work done during the fiscal year was, therefore, $30,168.80.

With the balance of funds available it is proposed to continue the work of dredging, and general repairs to above-water sections of the breakwater piers. These repairs are necessarily superficial, because the interior timber work is not accessible to examination except at great expense, and the practical result is that only such defects as are in sight are repaired; the unseen interior, on which the integrity of the whole depends, remains untouched until large sections of the perishable part above water, with its stone-filling, and newly repaired surface perhaps, are carried away during some storm period. Such repairs may serve to hold the steadily decaying body together for a greater or less time, but eventually the whole superstructure must give way under the assault of some storm wave. It is submitted that the best policy is to replace such portions by new superstructure of concrete or other masonry, and means should be provided for so doing as occasion occurs. The substructure, being all below water, does not decay, and may be depended upon as a substantial foundation for the superincumbent masonry. The lake-side face timbers for a few feet below the water line are liable to injury by the grinding of ice floes, but their protection by iron-plating has shown itself easily practicable and effective. Regarding this course as of supreme importance, and one of true economy in bringing the exposed works of this extensive harbor to a condition of substantial permanence, I am impelled to urge that the next appropriation provide a sum of at least $100,000 as an initial step in that direction, to be applied as breaches may be made, or such evidence of weakness developed as to show imminent danger of collapse. Continuation of the work of deepening the harbor by dredging is highly desirable, for which purpose, and for the cost of operating and care, miscellaneous repairs of piers and plant, and engineering superintendence and contingencies, a further sum of $50,000 is requisite. The appropriation recommended for 1896 is, therefore, $150,000.

The number of vessels that entered this harbor for refuge during the past fiscal year was 991, with a total tonnage of 384,670; the grand total of vessels so entering from 1877 to 1893, inclusive, was 20,375, the tonnage of which aggregated 6,451,022. The size of vessels entering has grown from an average tonnage of 289 in the year 1877 to 385 in the year just closed.

Appropriations for improving harbor of refuge at Sand Beach, Lake Huron, Michigan.

March 3, 1871	$100, 000	March 3, 1881	$50, 000
June 10, 1872	100, 000	August 2, 1882	75, 000
March 3, 1873	75, 000	July 5, 1884	75, 000
June 23, 1874	75, 000	August 5, 1886	75, 000
March 3, 1875	100, 000	August 11, 1888	70, 000
August 14, 1876	75, 000	September 19, 1890	30, 000
June 18, 1878	100, 000	July 13, 1892	150, 000
March 3, 1879	75, 000		
June 14, 1880	75, 000	Total	1, 300, 000

Original estimated cost of the work	$1, 442, 500. 00
Whole amount appropriated, 1871 to and including act of July 13, 1892	1, 300, 000. 00
Amount carried to surplus fund	30, 000. 00
Whole amount expended to June 30, 1894	1, 133, 078. 53

Money statement.

July 1, 1893, balance unexpended		$180, 813. 68
June 30, 1894, amount expended during fiscal year		43, 892. 21
July 1, 1894, balance unexpended		136, 921. 47
July 1, 1894, outstanding liabilities	$7, 235. 66	
July 1, 1894, amount covered by uncompleted contracts	30, 493. 83	
		37, 729. 49
July 1, 1894, balance available		99, 191. 98
Amount that can be profitably expended in fiscal year ending June 30, 1896		150, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

No. 1.—*Record of vessels taking shelter in the harbor of refuge, Sand Beach, Mich., from July 1, 1893, to June 30, 1894.*

Direction of wind at time of entering, etc.	1893.						1894.				Total.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mar.	Apr.	May	June.	
North:											
Steam	6	15	12	5	3	......	......	12	6	3	62
Sail	1	9	6	3	2	......	......	7	10	3	41
Tow	11	11	12	6	......	......	......	5	1	1	47
Total	......	......	......	......	......	......	......	......	......	......	150
Northwest:											
Steam	8	1	39	23	9	2	2	3	5	12	104
Sail	6	1	6	8	......	......	......	......	6	10	37
Tow	3	......	18	15	3	......		1	......	13	53
Total	......	......	......	......	......	......	......	......	......	......	194

No. 1.—*Record of vessels taking shelter in the harbor of refuge, Sand Beach, Mich., from July 1, 1893, to June 30, 1894*—Continued.

Direction of wind at time of entering, etc.	1893.						1894.				Total.
	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Mar.	Apr.	May.	June.	
West:											
Steam	4	......	14	5	44	1	......	2	17	4	91
Sail	6	......	5	6	5	......	......	2	5	10	39
Tow	......	......	20	2	29	......	......	1	18	......	70
Total	......	......	......	......	......	......	......	......	......	......	200
Southwest:											
Steam	4	3	23	12	22	......	1	1	2	4	72
Sail	9	3	6	3	7	......	1	2	......	12	43
Tow	1	2	1	6	13	......	2	1	......	2	28
Total	......	......	......	......	......	......	......	......	......	......	143
South:											
Steam	4	......	2	5	15	7	1	2	4	2	42
Sail	3	1	3	1	9	......	1	......	5	8	31
Tow	......	......	......	1	3	2	......	1	......	......	7
Total	......	......	......	......	......	......	......	......	......	......	80
Southeast:											
Steam	5	12	20	25	10	......	......	4	7	3	86
Sail	6	6	6	13	4	......	......	1	7	7	50
Tow	......	6	12	16	8	......	......	3	......	1	46
Total	......	......	......	......	......	......	......	......	......	......	182
East:											
Steam	3	......	......	1	......	......	......	......	1	1	6
Sail	1	......	......	......	......	......	......	2	......	1	4
Tow	......	......	......	......	......	......	......	......	......	......	......
Total	......	......	......	......	......	......	......	......	......	......	10
Northeast:											
Steam	......	3	8	......	......	......	......	1	5	3	20
Sail	......	......	3	......	......	......	......	......	3	1	7
Tow	......	2	2	......	......	......	......	......	......	1	5
Total	......	......	......	......	......	......	......	......	......	......	32
Monthly total:											
Steam	34	34	118	76	103	10	4	25	47	32	483
Sail	32	20	35	34	27	......	2	14	36	52	252
Tow	15	21	65	46	56	2	2	12	19	18	256
Total	81	75	218	156	186	12	8	51	102	102	991

No. 2.—*Classified table of tonnage, by months, entering the harbor of refuge, Sand Beach, Mich., from July 1, 1893, to June 30, 1894.*

Months.	Steam.		Sail.		Tow.		Total.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
1893.								
July	34	8,863.93	32	1,892.50	15	4,683.38	81	15,439.81
August	34	14,559.99	20	1,688.93	21	9,135.33	75	25,384.25
September	118	60,644.19	35	3,824.40	65	28,687.28	218	93,155.87
October	76	43,548.57	34	4,261.51	46	21,134.61	156	68,944.69
November	103	66,415.81	27	3,309.74	56	25,233.15	186	94,958.70
December	10	4,563.54	......	....	2	549.14	12	5,112.68
1894.								
March	4	640.89	2	458.10	2	697.95	8	1,796.94
April	25	10,987.90	14	824.60	12	5,669.09	51	17,481.59
May	47	28,397.49	36	2,125.37	19	8,622.44	102	39,145.30
June	32	11,384.56	52	3,952.66	18	7,912.88	102	23,250.10
Total	483	250,006.87	252	22,337.81	256	112,325.25	991	384,669.93

No. 3.—*Tonnage of vessels taking shelter in the harbor of refuge, Sand Beach, Mich.*

Calendar year.	Steam.	Sail.	Tow.	Total.	Total vessels.	Average tonnage.
1877	63,966	27,699	50,954	142,619	493	289
1878	104,025	39,690	99,282	243,006	781	311
1879	133,080	45,750	100,096	278,926	921	303
1880	158,720	55,630	147,260	361,610	1,317	275
1881	144,645	55,960	127,855	328,460	1,176	279
1882	146,132	26,504	114,067	286,703	1,022	280
1883	177,122	32,713	114,091	323,926	1,139	284
1884	156,518	34,724	122,980	314,222	1,142	275
1885	196,364	29,426	151,607	377,397	1,158	325
1886	196,335	33,790	140,862	370,987	1,304	284
1887	271,327	33,689	153,087	458,103	1,447	317
1888	271,917	39,756	202,191	513,864	1,624	316
1889	289,719	37,922	165,896	493,537	1,512	326
1890	325,852	38,826	169,104	533,782	1,575	339
1891	292,917	27,076	171,067	491,060	1,341	366
1892	362,486	29,465	162,605	554,556	1,441	384
1893	243,451	20,897	113,915	378,264	982	385
Total	3,534,576	609,526	2,306,919	6,451,022	20,375	317

L L 21.

IMPROVEMENT OF BLACK RIVER AT PORT HURON, MICHIGAN.

This stream passes through the city of Port Huron, Mich., and empties into the St. Clair River. Before improvement it had a general channel depth of not less than 10 feet, reduced to 8½ feet at several shoals. The river and harbor act of September 19, 1890, appropriated $25,000 for dredging the channel to a depth of 16 feet. Work was commenced in the year following, and continued until August, 1892, when 184,989 cubic yards had been dredged, resulting in a channel 16 feet deep, 150 feet wide from the mouth to the Flint and Pere Marquette Railway bridge, 600 feet above, thence 100 feet wide to Haynes's lumber dock, 4,700 feet farther up, and thence 50 feet wide for the remaining distance of 3,000 feet to the Grand Trunk Railway bridge. Such was the condition of the improvement June 30, 1893.

Operations during the past fiscal year were in continuation of the work, under an appropriation of $10,000 made by the river and harbor act of July 13, 1892, which called for the extension of the dredged channel to Washington avenue, 1,400 feet above the Grand Trunk bridge, contract for the work having been entered into with L. P. & J. A. Smith, of Cleveland, Ohio, June 7, approved June 19, 1893. Work was commenced July 17, and continued to September 28, when the appropriation was exhausted and contract closed, with the excavation of 46,630 cubic yards. The 50-foot section of channel below the Grand Trunk bridge was thereby widened to 75 feet, and a channel 50 feet wide, 16 feet deep, made from that bridge to Washington avenue, 1,400 feet above. The total length of channel dredged to 16 feet from the mouth of the river up to Washington avenue is 9,700 feet, with widths hereinbefore noted.

Inspection of the condition of the improvement made June 19, 1894, showed a general depth of 16 or 17 feet, with occasional soundings of 14 and 15 feet, from the mouth to Seventh street bridge, a distance of about half a mile; thence to the end of channel dredged to a width of 100 feet, nearly half a mile farther up, a general depth of 15 to 16 feet with a few soundings of from 12 to 14 feet toward the upper limit; thence to the Grand Trunk bridge, through the section dredged to a width of 75 feet, the general depth was only 12 or 13 feet. This shows a rapid filling of the narrower upstream channel, and a gradual deterioration of the wider one below, by which the depth has been reduced until a point about half a mile above the mouth of the river is reached; the indications are that the narrow channels will soon be obliterated and the wider one below suffer gradual deterioration by progressive filling from the upper limit down to the mouth of the river. It is evident that but little permanent benefit can be expected from the narrow channels, and in restoring the channel depths widths of not less than 100 feet should be established. The estimate for 1896 below is submitted with that purpose in view.

Appropriations for improving Black River, Michigan, at Port Huron.

September 19, 1890	$25,000.00
July 13, 1892	10,000.00
Total	35,000.00
Original estimated cost of 15-foot channel, 1889	55,110.00
Original estimated cost of 16-foot channel, 1891	75,000.00
Whole amount appropriated 1890 to and including act of July 13, 1892	35,000.00
Whole amount expended to June 30, 1894	34,698.65

Money statement.

July 1, 1893, balance unexpended	$10,000.15
June 30, 1894, amount expended during fiscal year	9,698.80
July 1, 1894, balance unexpended	301.35
July 1, 1894, outstanding liabilities	12.80
July 1, 1894, balance available	288.55
Amount (estimated) required for completion of existing project	40,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS, BLACK RIVER, MICHIGAN.

Entrances and clearances.

Calendar year.	Number.	Revenue collected.	Tonnage.
1889	1,612		578,489
1890	2,225		547,954
1891	2,320		578,430
1892 *			
1893	602		71,415

* Not stated.

Receipts and shipments by vessels, 1893.

[Compiled from statement furnished by the collector of customs.]

Articles.	Quantity.	Tons.	Articles.	Quantity.	Tons.
RECEIVED.			RECEIVED—continued.		
Brick ... M	1,500	3,750	Wood ... cords	16,500	24,750
Cedar posts ... number	155,500	3,110			
Coal		38,983	Total		175,081
Laths ... M	3,948	1,184			
Live stock ... head	2,123	1,061	SHIPPED.		
Logs ... cubic feet	3,000,000	72,000	Lath ... M	1,000	300
Lumber ... M feet, B. M	15,583	27,270	Lumber ... M feet, B. M	1,250	2,187
Salt ... barrels	1,500	210	Machinery		5,000
Shingles ... number	12,082,500	1,513			
Stones ... cords	200	1,250	Total		7,487

L L 22.

IMPROVEMENT OF MOUTH OF BLACK RIVER, MICHIGAN.

An extensive bar and shoal formerly existed in the St. Clair River, adjoining the mouth of the Black; the bar lying close to the American side obstructed approach to the Port Huron docks, while the shoal, known as the "middle ground," comprised an area of nearly 50 acres and crowded the main channel in a sharp curve close to the Canadian shore. These conditions combined to prevent access to the river front of Port Huron, and to expose the vast through commerce of the Lakes to the dangers of navigating a narrow and crooked channel with a current of high velocity. In 1871 a project for dredging the bar and middle ground to a depth of 15 feet was submitted, which provided for excavating 257,200 cubic yards at a total estimated cost of $120,660. The work was commenced in 1872 and continued to 1878, when the improvement was completed. An examination made in 1886 showed that a deposit of about 6 inches had taken place, but no further work was done until 1889, when a new project for dredging to a uniform depth of 16 feet was adopted, and operations commenced under an appropriation of $10,000 made by the river and harbor act of August 11, 1888; continuing with additional appropriations the improvement was completed in 1892, including a small area dredged to a depth of 18 feet, adjoining the main channel.

No work was done during the last fiscal year, nor is there present need for any; but the shoal is slowly reforming, and the draft of lake craft is steadily increasing, so that it will not be long before further dredging will be required. It is important to the whole commerce of the Lakes that the channel at this place be kept in the best possible condition, and the estimate of $10,000 herewith submitted is intended to provide means for doing so.

Appropriations for improving St. Clair River at mouth of Black River, Michigan.

Mouth of Black River, in St. Clair River, Michigan:	
June 10, 1872	$15,000
St. Clair River, at mouth of Black River, Michigan:	
March 3, 1873	15.000
June 23, 1874	15,000
March 3, 1875	10,000
St. Clair River—Continued.	
June 18, 1878	$1,500
Mouth of Black River, Michigan:	
August 11, 1888	10,000
September 19, 1890	10,000
July 13, 1890	10,000
Total	86,500

Original estimated cost of (1871) of removing middle ground—	
To depth of 15 feet	$67,320.00
To depth of 18 feet	157,520.00
Whole amount appropriated 1872, to and including act of July 13, 1892.	86,500.00
Whole amount expended to June 30, 1894	86,393.90

Money statement.

July 1, 1893, balance unexpended	$651.42
June 30, 1894, amount expended during fiscal year	545.32
July 1, 1894, balance unexpended	106.10
July 1, 1894, outstanding liabilities	106.10
Amount that can be profitably expended in fiscal year ending June 30, 1896. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,000.00

L L 23.

IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

This river is a narrow and crooked stream, discharging into Anchor Bay, the northwest arm of Lake St. Clair, and has always been navigable for light-draft vessels to Mount Clemens, Mich., a distance of 8 miles by river. Before improvement the bar at its mouth afforded a navigable depth of only 3½ feet, and the depth on shoals was from 5 to 6 feet, but the general channel depth was 10 feet. The river and harbor act of July 7, 1870, appropriated $5,000 for its improvement, and in the absence of any surveys of the river this sum was applied to dredging a channel about 60 feet wide, 9 feet deep, and 2,700 feet long, upward from the mouth. The principal obstruction to navigation was thereby removed, but the improvement gradually deteriorated, and by 1880 was obliterated, as shown by a survey then made, pursuant to the River and Harbor act of March 3, 1879. A project of improvement from the mouth to Mount Clemens, based on this survey, was then begun, with a view to making a through 8-foot channel, protected by suitable revetments where needed; its estimated cost was $25,000, revised and amended in 1888 and 1889 to $34,564. The work has been done, but with such small appropriations, that the erection of substantial structures of a permanent character has been impossible, and until this is done the improved channel will rapidly fill up again. This is especially the case with respect to works at the entrance, where the movement of ice from Anchor Bay must be resisted by structures more substantial than any that could be put up with money heretofore available, and none thus far erected have withstood the strain for any considerable time. Repeated dredgings have therefore been required to keep the entrance channel open, and expenditures for this purpose, for dredging in the river above, and for the erection of light revetments as temporary aids for the maintenance of dredged channels, have absorbed the meager appropriations, and left no work of a permanent character in sight.

Operations during the past year were as follows:

Work was in progress at the beginning of the year under contract with Michaël Steiner, approved October 17, 1892, for constructing two sections of training dike, to protect the channel at the mouth of the river. The inner section, 327.5 feet long, consists of a single row of piles driven at intervals of 8 feet, with cap timber and wale pieces, all constituting a support for a row of double sheet piling, secured at top to the wale piece by seven bolts. The outer section, 867 feet long, consists of two rows of round piles, 8 feet apart, piles of each row driven at intervals of 8 feet, capped with 12 by 14 inch timber, and the two rows connected at top by a timber cross-tie at the middle of each pile interval; and 4 by 10 inch guide strip secured to the rear of piles in the front row, 4 feet below the cap timbers, afford bearing to a double row of sheet piling, which is spiked to the cap and guide pieces. This work was completed about the middle of October, at a cost of $6,505.38, for the pile and timber work in place. A narrow channel 10 feet deep was dredged 15 feet from face of the work between November 15 and 30, and the excavated material cast over as a backing to the pile structures; the amount dredged was 5,174 cubic yards, at a cost of 14½ cents per cubic yard, or in all $750.23.

The condition of the improvement was examined June 19, when the least depth found in the dredged channel was 9½ feet, but the depth just above the limit of last year's dredging was only 7 feet, and is as low as 6 feet on some of the upper shoals. The pile work was found to be in good condition; but last winter's ice formation in this locality was most unusually light and it is quite certain that this condition will not last long, if the structure be not greatly strengthened before being exposed to the movement of such quantities of ice as have carried away all previous structures; the present one must be expected to go as the others, unless measures be taken to make it much more substantial and secure.

The aggregate of appropriations thus far made and applied to this project of improvement is $34,564, which is the sum total of the estimated cost of completion. It has sufficed to dredge and redredge the channel and to build and rebuild temporary works of protection, and to that extent the projected improvement has been completed; but as a question of completed improvement with any element of permanence the end is about as far off as it was in the beginning.

In the absence of any approved project for further work, it is impossible to submit an estimate for future operations. If the maintenance of a navigable channel is to depend on dredging and repairs of present protecting structures, an appropriation of $10,000 for 1896 is desirable. If the better and cheaper policy of giving to these structures the element of permanence be adopted, the next appropriation should be not less than $25,000.

It has been impracticable to obtain commercial statistics of Clinton River, Michigan.

Appropriations for improving Clinton River, Michigan.

August 30, 1852	$5,000	August 11, 1888	$10,000
July 11, 1870	5,000	September 19, 1890	10,000
March 3, 1871	1,500	July 13, 1892	8,564
March 3, 1881	8,000		
August 2, 1882	6,000	Total	60,064
August 5, 1886	6,000		

Original estimated cost of work, 1885, as amended in 1889	$34,564.00
Whole amount appropriated and expended prior to adoption of present project	25,500.00
Whole amount appropriated 1886, to and including act of July 13, 1892	34,564.00
Whole amount expended on present project to June 30, 1894	34,546.26

Money statement.

July 1, 1893, balance unexpended	7,328.94
June 30, 1894, amount expended during fiscal year	7,311.20
July 1, 1894, balance unexpended	17.74
Amount that can be profitably expended in fiscal year ending June 30, 1896	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

L L 24.

IMPROVEMENT OF ROUGE RIVER, MICHIGAN.

Under the provisions of the river and harbor act of August 5, 1886, a survey of this river was made with a view to its improvement, and a project prepared for securing a channel depth of 16 feet with a width of

240 feet for a distance of 800 feet from the mouth, and thence with a width of 100 feet to the Wabash Railroad bridge, about 2⅔ miles farther up; the estimated cost was $31,690.39. At the time of survey this portion of the river had a natural channel from 10 to 17 feet deep, with a general width of about 175 feet.

The work of improvement was commenced in 1888 and completed in November, 1892, at a total cost of $30,272.79.

No work was done during the past fiscal year, and no complaints have been made concerning its navigable condition. Information was conveyed to this office during the month of May that the hull of the tug *W. A. Moore* had been beached in a bend of the river, stripped, and abandoned in such position as to obstruct navigation. Examination was made, the owners of the craft ascertained, and its speedy removal exacted.

The present commerce of the river is small, but the adaptability of its banks to the establishment of important industries, calling for ready and convenient facilities of transportation by rail or water, is certain to develop a busy commerce in time. For this reason the improvement already made should not be allowed to suffer material deterioration, and this can only be prevented by occasional dredging. An estimate of $5,000 for 1896 is therefore submitted, to be applied to dredging as necessity arises, in order that the present navigable condition of the stream may not become seriously impaired.

Appropriations for improving Rouge River, Michigan.

August 11, 1888	$10,000.00
September 19, 1890	10,000.00
July 13, 1892	11,690.00
Total	31,690.00

Original estimated cost of the work, 1887	31,690.39
Whole amount appropriated 1888, to and including act of July 13, 1892	31,690.00
Whole amount expended to June 30, 1894	30,281.94

Money statement.

July 1, 1893, balance unexpended	$1,417.21
June 30, 1894, amount expended during fiscal year	9.15
July 1, 1894, balance unexpended	1,408.06
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	5,000.00

COMMERCIAL STATISTICS, ROUGE RIVER, MICHIGAN.

Receipts and shipments by vessel, 1893.

[Compiled from statement furnished by Mr. George N. Brady, Detroit, Mich.]

Articles.		Quantity.	Tons.
Cedar posts	number	39,284	786
Gravel			5,000
Laths	number	4,358,000	1,307
Live stock	head	37	18
Lumber	feet, B. M.	26,369,296	46,146
Wood	cords	9,100	20,475
Total			73,732

L L 25.

CONSTRUCTION OF TURNING BASIN IN ROUGE RIVER, MICHIGAN.

The river and harbor act of September 19, 1890, called for an estimate for "locating and constructing basin in said (Rouge) river, at a point on the same within four miles of its junction with the Detroit River, convenient for the turning and anchoring of vessels." Such estimate was submitted by Col. O. M. Poe, Corps of Engineers, in a report dated December 20, 1890, as follows: Three acres of land for site at $1,500, $4,500; 74,074 cubic yards excavation, at 15 cents, $11,111.10; total, $15,611.10.

The next river and harbor act, approved July 13, 1892, appropriated $5,000 for acquisition of land and beginning construction, according to the foregoing project. The appropriation has been found too small for purchasing the land needed, and accordingly no work has yet been done or expenditure made in relation to the proposed improvement.

When local commerce shall have grown to such extent as to make the facilities of a turning basin more imperative than it is at present, it is probable that the Government will be put to but small expense for the land needed, if money should then be available for the prompt completion of the improvement. An appropriation of $10,500 to complete the improvement as projected is therefore recommended for the year 1896.

Money statement.

July 1, 1893, balance unexpended	$5,000.00
July 1, 1894, balance unexpended	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	10,500.00

L L 26.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

Removal of wreck, Presqu' Ile Harbor, Michigan.—The presence of this wreck was reported by the local light keeper through the Light-House Establishment and brought to the attention of this office in a letter from the Treasury Department, dated April 13, 1894, received here by indorsement dated April 19, 1894. The harbor was visited by the officer in charge April 23, and preliminary examination made, of which report, dated April 30, was submitted, describing the conditions as follows:

> The wreck (was) found, plainly marked by a can buoy of the U. S. Light-House Establishment No part of the wreck is above water, and the least depth found over it was 7.8 feet, with depths varying from 15 to 18 feet around it. It lies just inside the three-fathom curve, about 450 yards from the shore, and a little north of the range established for the guidance of vessels entering the harbor; the location is shown on blue print herewith. The wreck itself appears to be that of an old hulk, of which but little more than the frames are left, and is of no value whatever; no trace of ownership or information as to when or how it came there can be obtained. Situated as it is, and with the established aids to navigation, the wreck is not a very serious obstruction to navigation, nevertheless a vessel entering the harbor in heavy weather might get on it and receive considerable damage, and for this reason I am of the opinion that it should be broken up and leveled to the bottom. This may probably be done at a cost of $300 or certainly for a sum not exceeding $500, and I

would recommend that the latter amount be allotted and placed to my credit for the purpose of removing the obstruction at the first favorable opportunity.

Instructions were thereupon issued from the office of the Chief of Engineers, dated May 4, authorizing the removal of the wreck as proposed, and the sum of $500 was allotted "from the permanent indefinite appropriation for removing sunken vessels or craft obstructing or endangering navigation—act June 14, 1880—to pay the attendant expenses of the work." Under this authority the officer in charge made a second visit to the harbor June 14, and after careful examination concluded to engage the services of a diver to assist in the work of removal. Accordingly, the diver from Sand Beach Harbor was met there June 25, and on the day following he made full inspection, from which it appeared that the wreck was a very old one, comprising most of the hull of what appeared to have been a large tug, or other steam vessel, about 90 feet long, the sides projecting from 6 to 10 feet above the bottom of the lake. The conclusion was reached that the obstruction could be best removed by sawing the wreck in sections that could be readily handled by a small derrick rigged on the diver's scow, and depositing the parts so taken out on the shore. The diver was instructed to proceed in that way and remove all parts projecting above the bottom, or in any way reaching within 16 feet of the water surface. Operations to that end were thereupon commenced and were in progress at the close of the year, with the prospects of completion by or before July 15.

L L 27.

ESTABLISHMENT OF HARBOR LINE IN ST. JOSEPH HARBOR, MICHIGAN.

ST. JOSEPH, MICH., *May 7, 1894.*

DEAR SIR: Herewith find plan and specifications for new wharf at St. Joseph, Mich. Your petitioner respectfully begs permission to construct a new wharf opposite wing dam on your petitioner's mill property, "on a straight line between D and C wharves to a snub or tie pile on Vandalia Railroad wharf, about 400 [40] feet westerly from angle in Vandalia wharf," by so doing making the river about 10 feet wider than shown on map. The reason for asking permission for straightening the line is that a vessel could only unload on one side or the other of the angle, thereby causing unnecessary delay in unloading. Another reason or objection to the angle is that a bar would be forming continually on account of slack water.

Yours, very truly,

W. A. PRESTON.

Hon. DANIEL LAMONT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 10, 1894.

Respectfully referred to Lieut. Col. G. J. Lydecker, Corps of Engineers, for report.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Detroit, Mich., June 1, 1894.

Respectfully returned to the Chief of Engineers, U. S. Army, with report.

G. J. LYDECKER,
Lieut. Col. of Engineers.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 5, 1894.

Respectfully returned to the Secretary of War.

This is an application from Mr. W. A. Preston, of St. Joseph, Mich., for authority to build a new wharf in front of his mill property at that place.

The application has been referred to Lieut. Col. G. J. Lydecker, Corps of Engineers, and that officer, after careful consideration of the matter, makes the following recommendations:

1. That the full red line C D on the blue prints herewith be established and adopted as the harbor line for this portion of St. Joseph Harbor, under authority of section 12 of the act of Congress of September 19, 1890.

2. That Mr. Preston's application be approved, subject to the conditions that the new wharf be built to conform with the harbor line above indicated, and in accordance with specifications submitted with his application modified so as to make the piles 30 feet long in the work, and sheet piling 24 feet long; provided also that the rear supports shall be a line of anchor piles and no "deadmen."

All work to be subject to the supervision of the United States engineer in charge of the harbor, and to be completed to his satisfaction.

Blue prints* showing location and construction of the dock as recommended are herewith.

I concur in the views and recommendations of Lieut. Col. Lydecker, and recommend that the Secretary indicate his approval of the harbor line by placing his signature on the blue print* marked "A."

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT, *June 8, 1894.*

Respectfully referred to the acting Judge-Advocate-General to prepare the necessary papers.

The harbor line adopted for the portion of St. Joseph's Harbor referred to in the previous indorsement is approved.

JOSEPH B. DOE,
Acting Secretary of War.

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* Not printed.

REPORT OF LIEUT. COL. G. J. LYDECKER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., June 1, 1894.

GENERAL: I have the honor to submit report on the application of W. A. Preston to the Secretary of War, dated May 7, 1894, for authority to build a new wharf in front of his mill property at St. Joseph, Mich., as follows:

On receipt of his application I sent to Mr. Preston a blue print of the locality referred to, with request that he indicate thereon the precise line and limits of his proposed structure; his reply, dated May 28, is inclosed herewith,* from which it is seen that this line was incorrectly described in the original application as intersecting the Vandalia Railroad wharf "about 400 feet westerly from the angle," instead of 40 feet from that point. The broken red line A B on the inclosed blue print* shows the location contemplated by Mr. Preston, and it is not open to any serious objection; but a better condition of affairs would, in my opinion, result from adopting the full red line C D, which, being parallel to and 300 feet from the wing dam opposite, would give a uniform width of channel and leave a less projecting salient at A than that at C. The specifications submitted should be modified to call for piles 30 feet long, in the work, and for sheet piling 24 feet long, to conform with requirements heretofore made for similar structures at this harbor; and the use of "deadmen" or anchors should not be permitted as a substitute for "anchor piles."

I therefore submit the following recommendations:

1. That the red line C D, on blue print herewith, be established and adopted as the harbor line for this portion of the harbor, under authority of section 12 of the river and harbor act of September 19, 1890.
2. That Mr. Preston's application be approved, subject to the conditions that the new wharf be built to conform with the harbor line above indicated, and in accordance with specifications submitted with his application modified so as to make the piles 30 feet long in the work, and sheet piling 24 feet long; provided also that the rear supports shall be a line of anchor piles and no "deadmen." All work to be subject to the supervision of the United States engineer in charge of improvements at the harbor, and to be completed to his satisfaction.

Blue prints, three copies of each, are transmitted herewith, showing location and construction of the dock as herein recommended.

Very respectfully, your obedient servant,

G. J. LYDECKER,
Lieut. Col. of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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* Not printed.

APPENDIX M M.

IMPROVEMENT OF WATERS CONNECTING THE GREAT LAKES.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo.
2. Operating and care of St. Marys Falls Canal, Michigan.
3. St. Marys River at the falls, Michigan.
4. Hay Lake Channel, St. Marys River, Michigan.
5. St. Clair Flats Canal, Michigan.
6. Operating and care of St. Clair Flats Canal, Michigan.
7. Grossepoint Channel, Michigan.
8. Detroit River, Michigan.
9. Investigation of raft-towing on the Great Lakes and their connecting waters.

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., July 9, 1894.

GENERAL: I have the honor to transmit herewith the annual reports * * * relating to the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1894.

* * * * * * *

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Colonel, Corps of Engineers,
Bvt. Brig. Gen., U. S. A.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

M M 1.

IMPROVEMENT OF SHIP CHANNEL CONNECTING WATERS OF THE GREAT LAKES BETWEEN CHICAGO, DULUTH, AND BUFFALO.

Before improvements were commenced under the project for this work the available depth for navigation in the connecting waters of the Great Lakes was about 16 feet.

The ultimate attainment of a navigable depth of 20 feet was foreseen when the following projects were adopted: Improving St. Marys River at the falls and in Hay Lake Channel, improving St. Clair Flats Canal, and improving Detroit River at Lime Kiln Crossing.

An available depth of 20 feet having been provided for at St. Marys Falls Canal, Hay Lake Channel, and at Lime Kiln Crossing by previous acts of Congress, the remaining shallows in the connecting waters of the Great Lakes, with the exception of some shoals in Detroit River between the city of Detroit and Lake Erie, were grouped into one project.

The river and harbor act of July 13, 1892 appropriated $375,000, as follows:

> For ship channel twenty and twenty-one feet in depth and a minimum width of three hundred feet in the shallows of the connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, three hundred and seventy-five thousand dollars: *Provided,* That contracts may be entered into by the Secretary of War for such materials and work as may be necessary to carry out the plans proposed by General O. M. Poe, Corps of Engineers, United States Army, dated January twentieth, eighteen hundred and ninety-one, and printed as House Executive Document, numbered two hundred and seven, second session, Fifty-first Congress, for such ship channel, to be paid for as appropriations may from time to time be made by law, not to exceed in the aggregate two million nine hundred and sixty-five thousand dollars, exclusive of the amount herein appropriated.

The present project contemplates the excavation of a ship channel having a navigable depth of 20 feet in the shallows of the connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo for the benefit of navigation, at an estimated cost of $3,340,000.

The work is divided into eight sections according to locality, and the following channels are to be or have been excavated:

Section 1, a channel 21 feet deep and 300 feet wide at Round Island Shoals, St. Marys River.

Section 2, a channel 21 feet deep and 300 feet wide in Little Mud Lake, St. Marys River, between the lower end of Sugar Island and the lower end of the "Dark Hole."

Section 3, a channel 21 feet deep and 300 feet wide through a reef in St. Marys River abreast of Sailors Encampment Island.

Section 4, a channel 21 feet deep and 300 feet wide through a shoal in Mud Lake, St. Marys River, 1½ miles below Sailors Encampment Island.

Section 5, a channel 21 feet deep and 2 400 feet wide at the foot of Lake Huron.

Section 6, a channel 20 feet deep from deep water in St. Clair River, through St. Clair Flats Canal, to deep water in Lake St. Clair, with a width above St. Clair Flats Canal not greater than 650 feet; thence gradually narrowing to the canal; thence for the full width of the canal for its entire length; thence gradually widening to a width of 800 feet at deep water in Lake St. Clair.

Section 7, a channel 20 feet deep and 800 feet wide through Grossepoint Flats, Lake St. Clair, Michigan.

Section 8, a channel 21 feet deep and 800 feet wide through the bar at the mouth of Detroit River.

To obtain a navigable depth of 20 feet a depth of 21 feet is required where the excavation is through solid rock or through shoals infested with bowlders, and a depth of 20 feet where the cut is through soft material.

Contracts for the excavation specified above were entered into December 31, 1892, and, if no failure occurs in the appropriations, the contract time for the completion of the specified channels is November 30, 1895. Section 4 has been completed and the contract closed.

The datum planes for sections 1, 2, 3, and 4 are so selected as to give

20 or 21 foot navigation, according to conditions stated above, at a mean stage of water. The depth of water available at St. Marys Falls Canal at same stage will be 21.83 feet.

The datum planes for sections 5, 6, 7, and 8 (foot of Lake Huron to mouth of Detroit River) are so selected as to give 20 or 21 foot navigation at a stage which is the mean of lowest waters during navigation season.

The general map showing sections 1, 2, 3, and 4, together with the location of other works in St. Marys River, and a general map of waterway between lakes Huron and Erie, showing sections 5, 6, 7, and 8, are transmitted herewith.

SURVEYS.

The preliminary surveys for controlling and estimating the work have all been made.

At the time the project was submitted for a ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, it was based upon such information as was immediately available. At the same time it was borne in mind that a general examination and survey of the waterway in the vicinity of the work in progress should be made in order to ascertain whether there were other areas that should be improved in order to secure a clear depth of 20 feet in the connecting waters of the Great Lakes.

In connection with section 1 a system of triangulation was accordingly planned between Point Iroquois and the canal, the angles read, and the necessary computations made. Each station of this system is the center of a half-inch hole drilled 3 inches deep in a piece of limestone about 1 foot square. The stones are placed 3 feet under ground. The surface mark is a nail in the top of a cedar post.

In connection with section 8 a similar scheme of triangulation connecting the stations, for controlling the work, with old lake survey stations was planned. The field work of this triangulation was completed and the stations will be permanently marked.

Hydrography.—The general plan is to make use of the detailed soundings taken for the final estimates on the dredged shoals; also, to take soundings every 50 feet on each of the cross sections, which are 500 feet apart.

It is intended to sound through the ice, except where there are rapids.

The azimuths from at least two shore triangulation stations are determined to the points of intersection of three or more parallel lines with each of the cross-section lines, the parallel lines varying from 1,000 to 5,000 feet apart.

In the field work the points are located on the ice by transit intersections, and are marked with 3-foot stakes placed in auger holes.

The ice-boring machine starts at a stake; one man 50 feet from machine helps pull it along by means of one-eighth inch wire bell cord, and while the other two men are boring a hole he gets on line with the flags at the stakes, and marks the place for the next hole. The leadsman follows with a sounding pole, and lead line on a reel mounted on runners. It takes seven seconds to make a sounding in 60 feet of water.

The coordinates and azimuths for the areas to be sounded in the reach from Point Iroquois to the canal were computed; 5,700 soundings were taken between Point Iroquois and the Indian Mission; 14,600 soundings were taken on the Middle Ground Shoal above Round Island. The survey of Shoal 3, which lies between the west entrance to the canal and Big Point was completed; 4,000 soundings were taken between Round Island and Point Louise. Estimates for the removal of any of these shoals can be made from the data described above. The ice last winter was poor and went out early. The use of the three ice augers proved highly satisfactory, and especially so the one with the bevel gearing 98 to 28.

I wish to call special attention to the Shoal 3, shown on map of sections 1, 2, 3, and 4, forwarded herewith. This shoal is a menace to the navigation of vessels drawing more than 13 feet of water. It should have been included in the original project for ship channel, but was overlooked at the time. The recent survey shows that there are approximately 48,900 cubic yards of material above the 21-foot grade and inside of the lines that should mark the channel through this shoal.

Hydrography in vicinity of section 8.—The reach from Ballards Reef to Limekiln Crossing, Detroit River, having been swept in connection with the improvement of Detroit River, it was decided to sweep a channel 800 feet wide from the lower end of Limekiln Crossing to section 8, 20, and 21 foot channel. Obstructions above the grade for the 20 and 21 foot channel work were found. These obstructions will have to be removed in order to obtain a 20-foot channel in the connecting waters of the Great Lakes. The result of this sweeping is recorded on a map accompanying the report for improving Detroit River, Michigan. An estimate for the removal of these obstructions can be made at any time from the data recently obtained.

CONTRACTS.

List of contracts in force during fiscal year ending June 30, 1894.

Contractor.	For—	Entered into—	Remarks.
R. J. Cram	Excavation in section 1	Dec. 31, 1892	In force.
C. E. Mitchell & Co	Excavation in section 2	do	Do.
John Hickler	Excavation in section 3	do	Do.
Do	Excavation in section 4	do	Closed February, 1894.
McCollum & Lee	Excavation in section 5	do	In force.
R. J. Cram	do	do	Do.
James Rooney	Excavation in section 6	do	Do.
Breymann Bros	Excavation in section 7	do	Do.
L. P. & J. A. Smith	Excavation in section 8	do	Do.
J. L. Hudson	Stationery	Apr. 27, 1893	Do.
Ferguson Hardware Co	Hardware, ship chandlery, etc	do	Closed December, 1893.
Hickler Bros	Coal	do	Do.
T. C. Anthony	do	do	Do.
P. M. Church & Co	Hardware, ship chandlery, etc	Apr. 23, 1894	In force.
Prenzlauer Bros	Groceries	do	Do.
Andrew Hotton	Meats	do	Do.
J. B. Sweatt	Lumber	do	Do.
Hickler Bros	Coal	do	Do.

EXCAVATIONS UNDER CONTRACTS IN FORCE.

Excavation has been carried on under the nine contracts, entered into December 31, 1892. Each of the contracts, except the two for section 5, covers one section.

The two lowest bids for section 5 being the same, the work was divided and two contracts let. At the close of the fiscal year the condition of work on the different sections was as follows:

Section 1.—The material to be removed consisted of about 90,000 cubic yards, bank measure, of bowlders, clay, sand, gravel, and possibly hardpan. A depth of 21 feet is called for by the specifications, and the contract price is 44 cents per cubic yard.

The contractor, R. J. Cram, began work on June 1, 1893. The total to June 30, 1894, of the estimates for excavation is 73,583 cubic yards, bank measure, of which 63,153 cubic yards were excavated during the fiscal year. All the area comprised in this section has been dredged. In November last the raft bars were swung over both shoals and some bowlders were found above grade. These bowlders are still to be removed. Three thousand four hundred soundings were taken through the ice in March for the final estimate, and the computations for same have been made.

Section 2.—The material to be removed consisted of about 380,000 cubic yards, bank measure, of sand, gravel, bowlders, and hardpan, all in unknown proportions. A depth of 21 feet is called for by the specifications, and the contract price is 25.9 cents per cubic yard.

The contractors, C. E. Mitchell & Co., commenced work on June 13, 1893. The total to June 30, 1894, of the estimates for excavation is 197,608 cubic yards, bank measure, of which 164,201 cubic yards were excavated during the fiscal year. The rate of progress is 49 per cent greater than that required in the contract.

Section 3.—The material to be removed consisted of about 90,366 cubic yards, bank measure, mainly of limestone rock. A depth of 21 feet is called for by the specifications, and the contract price is $2.43 per cubic yard.

The contractor, John Hickler, commenced work on June 12, 1893, with one drill boat. This boat has continued work to date. One dredge commenced work in April, 1894. The total to June 30, 1894, of the estimates for excavation is 13,478 cubic yards, bank measure. The rate of progress is 48½ per cent less than that called for in contract. The contractor states that he will increase his plant.

Section 4.—The material to be removed consisted of about 173,218 cubic yards, bank measure, or mud, clay, sand, and gravel in unknown proportions. A depth of 21 feet was required by the specifications, and the contract price was 22 cents per cubic yard.

The contractor, John Hickler, commenced work on June 9, 1893, and completed the work on November 29, 1893. Total excavation, 233,855 cubic yards, bank measure, of which 211,640 cubic yards were excavated during the fiscal year. Sixty thousand eight hundred and fifty-seven cubic yards of the above total were between the 21 and 22 grades and were paid for at half price.

Section 5.—The material to be removed consisted of sand, clay, gravel, bowlders, and probably hardpan, all in unknown proportions, estimated at about 256,000 cubic yards, scow measure. A depth of 21 feet is required by the specifications, and the contract price is 58 cents per cubic yard.

McCollum & Lee, contractors for one-half of the work, commenced work on June 14, 1893. The total to June 30, 1894, of the estimates for excavation in this half, is 152,360 cubic yards, scow measure, of which 146,504 cubic yards were excavated during the fiscal year.

R. J. Cram, contractor for the other half, commenced work on May 10, 1894. The total to June 30, 1894, of the estimates for excavation in this half is 78,047 cubic yards, scow measure, all of which were excavated during the fiscal year. Total of estimates for excavation or section is 230,407 cubic yards, scow measure.

Section 6.—The material to be excavated consisted of about 950,000 cubic yards, scow measure, of clay and sand in unknown proportions. A depth of 20 feet is required, and the contract price is 16½ cents per cubic yard.

The contractor, James Rooney, commenced work April 20, 1893.

The total to June 30, 1894, of the estimates for excavation is 497,954 cubic yards, scow measure, of which 438,377 cubic yards were excavated during the fiscal year. The rate of progress in this section is greater than that required in the specifications, and the work now approaches completion.

Section 7.—The material to be removed consisted of 2,900,000 cubic yards, scow measure, of clay, gravel, sand, and some bowlders, with possibly some hardpan. A depth of 20 feet is required by the specifications, and the contract price is 14⅞ cents per cubic yard.

The contractors, Breymann Bros., commenced work April 17, 1893. The total to June 30, 1894, of the estimates for excavation is 604,954 cubic yards, scow measure, of which 539,970 cubic yards were excavated during the fiscal year. The rate of progress in this section is not as great as that required in the specifications.

Section 8.—The material to be excavated consisted of about 1,086,000 cubic yards, scow measure, of sand, clay, gravel, and bowlders, all in unknown proportions. A depth of 21 feet is required by the specifications, and the contract price is 18 cents per cubic yard.

The contractors, L. P. & J. A. Smith, commenced work June 1, 1893. The total to June 30, 1894, of the estimates for excavation is 183,242 cubic yards, scow measure, of which 178,565 cubic yards were excavated during the fiscal year. The rate of progress on this section is not as great as that required in the specifications.

Sections 1, 2, 3, and 4 of this work have been under the local charge of Assistant Engineer E. S. Wheeler, assisted at different times during the year by Assistant Engineers Joseph Ripley, Benno Rohnert, C. Y. Dixon, H. Von Schon, Glen E. Balch, and Mr. Thomas Russell, Clerk R. Common, Draftsman Mangelsdorf, and Inspector L. P. Morrison.

Sections 5, 6, 7, and 8 have been under the local charge of First Lieut. William L. Sibert, assisted by Assistant Engineer H. Kallman, and by Assistant Engineer A. L. Lucas for a portion of the time; by Inspector H. Kallman, jr., D. A. Hitchcock, C. W. Danger, J. C. Barton, and J. B. Yates.

The commerce through sections 1, 2, 3, and 4 of this ship channel will be practically the same as that through St. Marys Falls Canal; and the commerce through sections 5, 6, 7, and 8 will be about the same as that through Detroit River, Michigan.

The estimate for the work is $3,340,000, of which $1,250,000 has been appropriated, leaving $2,090,000 to be appropriated. To pay the various employés and contractors during fiscal year ending June 30, 1896, $500,000 will be required.

Expended during fiscal year (exclusive of outstanding liabilities)...... $362,882.46

Sections 1, 2, 3, and 4 are in the collection district of Superior, Mich. The nearest port of entry is Marquette, Mich., but Sault Ste. Marie is a subport.

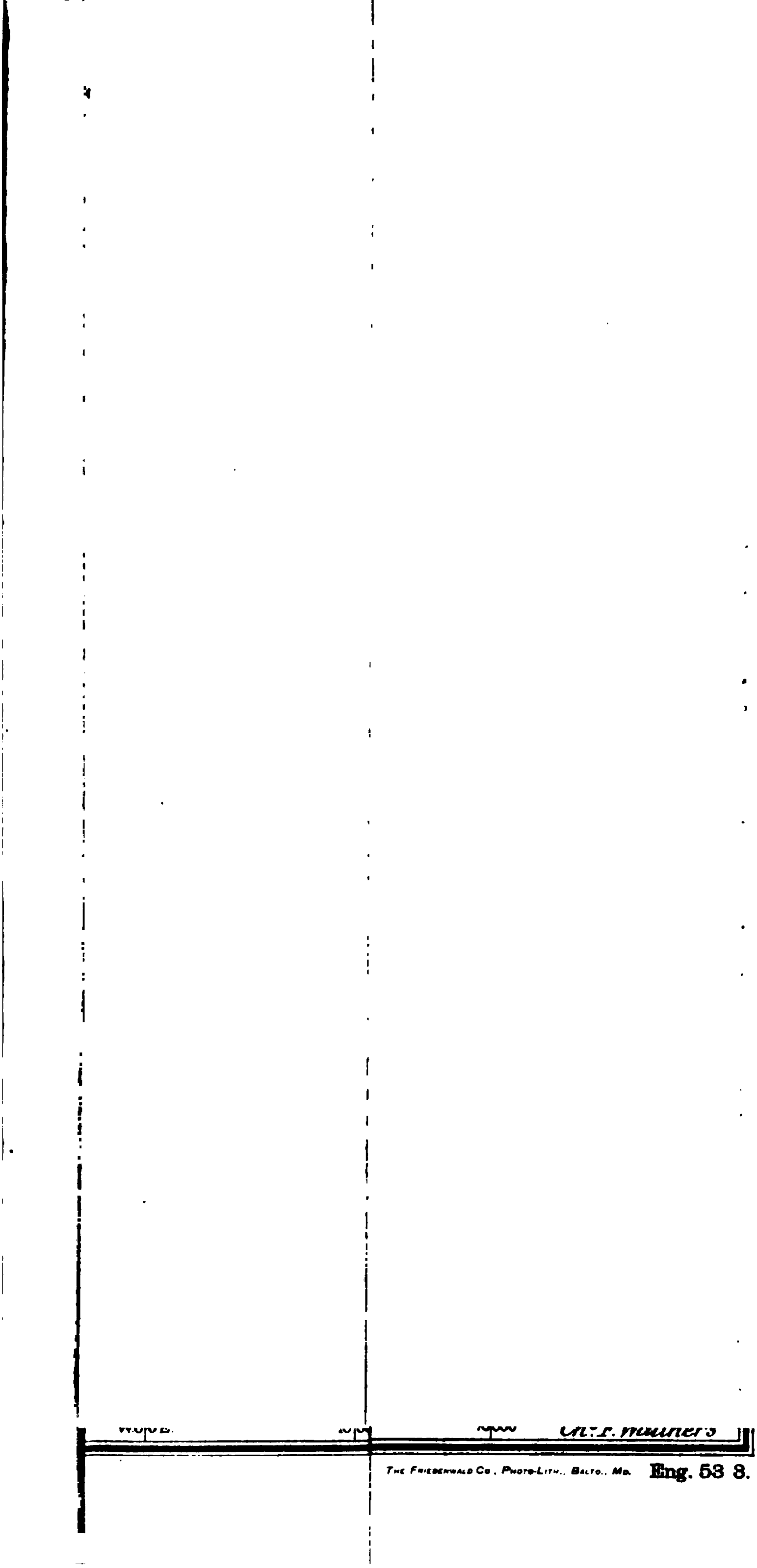
Section 1, nearest lights, Point Iroquois Light-House, St. Marys River upper and lower lights, Point Aux Pins Light (Canadian); section 2, nearest lights, Harwood Point ranges, Hen and Chicken ranges, Point of Woods ranges (American and Canadian), East and West Dark Hole ranges.

Section 3, nearest lights, Rains Hill ranges (Canadian), Point of Woods (Canadian), Encampment Crib Light.

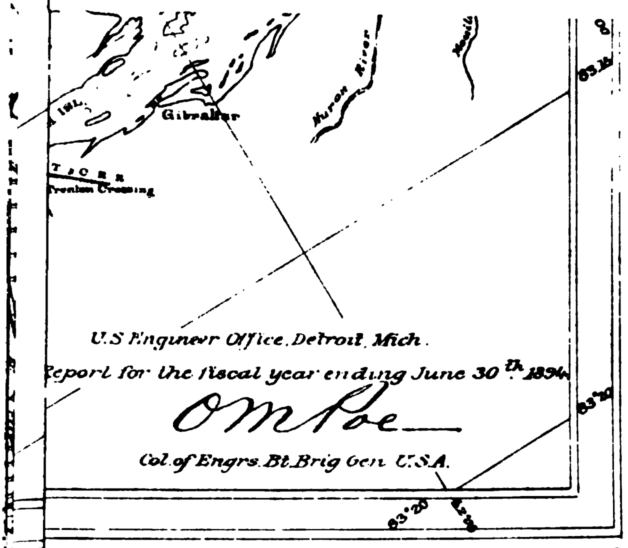
Section 4, nearest lights, Everens Point range lights (Canadian), Winter Point range lights.

Section 5 is in the collection district of Huron, Mich. The nearest port of entry is Port Huron, and the nearest light-house is Fort Gratiot Light.

Sections 6, 7, and 8 are in the collection district of Detroit, Mich. The nearest port of entry is Detroit, Mich. The nearest Light-Houses to section 6 stand on St. Clair Flats Canal; to section 7, Windmill Point Light-House and range lights vicinity; to section 8, Bois Blanc (Canadian) and the Detroit River Light-House.



The Friedenwald Co., Photo-Lith., Balto., Md. **Eng. 53 8.**



U.S Engineer Office, Detroit, Mich.

Report for the fiscal year ending June 30th 1894.

O M Poe

Col. of Engrs. Bt. Brig Gen. U.S.A.

The Friedenwald Co Photo-Lith., Balto., Md. **Eng. 53 8.**

Money statement.

July 1, 1893, balance unexpended		$1,226,763.60
June 30, 1894, amount expended during fiscal year		362,882.46
July 1, 1894, balance unexpended		863,881.14
July 1, 1894, outstanding liabilities	$162,357.35	
July 1, 1894, amount covered by uncompleted contracts	851,804.26	
		1,014,161.61
Amount (estimated) required for completion of existing project		2,090,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of bids for supplies for ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo, received and opened March 28, 1894, in accordance with advertisement dated March 8, 1894.

No.	Names and address of bidders.	Supplies.	Total.
1	P. M. Church & Co., Sault Ste. Marie, Mich	Hardware, ship chandlery, etc	* $1,439.11
2	Robert G. Ferguson, Sault Ste. Marie, Michm	do	1,479.78
1	Prenzlauer Bros., Sault Ste. Marie, Mich	Groceries	* 330.85
2	Allen Bros., Detroit, Mich	do	349.68
3	P. C. Keliher, Sault Ste. Marie, Mich	do	350.15
4	Peppard & McKinney, Sault Ste. Marie, Mich	do	358.22
5	G. & R. McMillan & Co., Detroit, Mich	do	366.64
6	Otto Supe & Co., Sault Ste. Marie, Mich	do	384.49
7	Jno. Blessed & Son, Detroit, Mich	do	422.64
1	Peppard & McKinney, Sault Ste. Marie, Mich	Vegetables, etc	* 397.66
2	P. C. Keliher, Sault Ste. Marie, Mich	do	458.12
3	Prenzlauer Bros., Sault Ste. Marie, Mich	do	† 324.29
4	Otto Supe & Co., Sault Ste. Marie, Mich	do	† 386.56
1	Andrew Hotton, Sault Ste. Marie, Mich	Meats	* 375.00
2	Donaldson & Hall, Sault Ste. Marie, Mich	do	390.00
1	J. B. Sweatt, Sault Ste. Marie, Mich	Lumber	* 258.40
2	E. D. Johnson, Sault Ste. Marie, Mich	do	319.20
3	Emery D. Weimer, Ludington, Mich	do	‡ 400.00
1	Hickler Bros., Sault Ste. Marie, Mich	Coal	* 885.00
2	L. D. Kemp, Sault Ste. Marie, Mich	do	915.00
3	Thomas C. Anthony, Sault Ste. Marie, Mich	do	915.00
4	Frank Perry, Sault Ste. Marie, Mich	do	015.00

* Recommended for acceptance. † Incomplete. No bid on milk.
‡ Incomplete. No bid on spruce plank.

M M 2.

OPERATING AND CARE OF ST. MARYS FALLS CANAL, MICHIGAN.

St. Marys Falls Canal, about 1 mile in length, forms part of the water route between Lakes Huron and Superior, and affords a means of passing the Sault de Ste. Marie, overcoming by its lockage system a difference of level of about 18 feet. The prism of the canal is of variable width, and has a depth of 16 feet at ordinary stages of water.

The original canal was constructed by the State of Michigan and was opened for traffic in 1855. In 1870 the United States began to enlarge the canal and to build a new and larger lock abreast of the old lock of 1855. This work was completed in 1881, and the entire canal passed into the control of the General Government.

In 1887 the locks of 1855 were rendered unavailable for further service by the construction of a cofferdam to inclose the site of a new lock which was projected to replace them. This new lock is to be 800 feet long between gates, 100 feet wide throughout, with 21 feet of water on the miter sills, and is to have a single lift of about 18 feet.

The lock of 1881, upon which the entire traffic of Lake Superior now depends, is 515 feet long between gates, 80 feet wide in the chamber, narrowing to 60 feet at the gates, with 17 feet of water on the miter sills, and overcomes the difference of level by a single lift of about 18 feet. Until the proposed 800-foot lock is finished, an accident to this lock would cripple the entire commerce of Lake Superior.

List of contracts in force during the fiscal year ending June 30, 1894.

Contractor.	For—	Entered into—	Remarks.
Emery D. Weimer	Lumber	Apr. 21, 1893	Closed December, 1893.
The Richmond & Backus Co.	Stationery	Apr. 27, 1893	In force.
P. M. Church & Co	Hardware, etc	...do	Closed December, 1893.
Thomas C. Anthony	Coal	...do	Do.
James Strachan	Machine work	...do	Do.
J. T. Wing & Co	Hardware, ship chandlery, etc	Apr. 14, 1894	In force.
E. D. Johnson	Lumber	...do	Do.
L. D. Kemp	Coal	...do	Do.

ORGANIZATION.

The organization remains practically the same as last season. The regular force consists of 1 superintendent, 3 assistant superintendents, 1 clerk, 3 foremen, 3 enginemen, 7 watchmen, and 27 lockmen. A small labor party, averaging about 15 men, have been employed during the working season in making repairs to buildings, care of grounds, etc.

ACCIDENTS AND DELAYS.

A boy was drowned in the canal on the 5th of August, 1893. He was employed on one of Dunbar & Sullivan's dredges. An unknown man was drowned in the canal on September 3. The body was recovered on the 9th, but was not recognized. On the 17th the steam barge *Brazil* struck an obstruction in the canal, injuring her bottom so that one compartment filled. An examination by a diver showed the obstruction to be a large bowlder which had been recently brought into the canal by the bight of a towline. It was immediately removed. There have been no other accidents of importance. There have been the usual number of short delays caused by grounding on the platform, obstructions on the miter sill, etc. Ther has, however, been but very little delay caused by grounding in the canal above the locks. This is due to the fact that the canal prism has been deepened the entire distance above the basin.

STAGE OF WATER.

The water in Lake Superior has been up to and above its normal. The water in St. Marys River has been about 1 foot below its normal. The lift in the lock has therefore been large, the monthly average sometimes exceeding 19¼ feet. The water in St. Marys River has been steadily rising, so that at the present there is an available depth of 15 feet on the platforms at the lower end of the lock. The lower lakes, Ontario, Erie, and St. Clair, are all up to their normal height. It is therefore probable that the middle lakes, Huron and Michigan, will soon be up to their normal level.

MOVABLE DAM.

The movable dam has been tested monthly and kept in perfect order, except that the horizontal girder has been pushed longitudinally outward, bending its suspension rods, so that when closed the north wicket comes in contact with the wall. This can easily be corrected by simply straightening the suspension rods. The dredging operations in the canal have caused a great deal of rock, sand, and earth to lodge against the sill; this has been removed from time to time.

PUMPING PLANT.

The floating pumping plant has been kept in good repair and constantly ready for use during the season of navigation.

CANAL POST-OFFICE.

The mail matter of people using the canal has been received and delivered as usual by the watchman. Mail is received and delivered at all times of night or day. The total mail handled during the year consisted of 69,794 pieces of matter, as follows: Letters, 62,876; postal cards, 2,623; papers and packages, 4,295; letters returned, 1,063; letters re-directed, 1,568. So far as is known no mail matter intrusted to the canal post-office has been lost.

LOCK FLOOR.

A portion of the anchor bolts of the lock floor have worn loose at the upper end. Two hundred of them in the western end were therefore lengthened, provided with large washers and nuts, and drawn so as to leave this portion of the floor level and in as good condition as ever.

ESTIMATES.

The project for operating and care of the canal for the fiscal year ending June 30, 1893, contemplates maintaining the present organization, purchasing the requisite supplies, moving any buildings belonging to the canal that may stand in the way of the work in progress for the enlargement of the canal, possibly constructing a new set of lower gates for the lock of 1881, purchasing the timber necessary for repairing the canal piers, possibly adding two stories to the present machine house, employing such labor as may be required in making current repairs and policing the grounds, and generally doing all things needful in maintaining the canal in an efficient condition.

The estimated cost of the foregoing is as follows:

Pay of regular lock force	$30,000
Pay of labor party	6,000
General purchases	5,000
Repairs and additions to machine house	10,000
Timber for repairing canal piers	4,000
Electric lights	2,000
Contingencies	6,000
Total	63,000

No estimate is included for extraordinary repairs which may be rendered necessary by accident. Such can not be foreseen, and therefore can not be estimated for.

In case of injury or damage to the canal beyond that due to ordinary wear and tear, it must be promptly made good at whatever cost.

All expenses of operating and care are provided for by indefinite appropriation under section 4 of the river and harbor act approved July 5, 1884.

Expended to June 30, 1893		$415,714.40
Outstanding liabilities June 30, 1893		4,102.80
Total to June 30, 1893		419,817.20
Expended during fiscal year ending June 30, 1894	$55,132.21	
Deduct outstanding liabilities pertaining to preceding year	4,102.80	
Total pertaining to current fiscal year		51,029.41
Add outstanding liabilities June 30, 1894		4,183.68
Total to June 30, 1894		475,030.29

St. Marys Falls Canal is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. Two beacons stand upon the piers at the western end of the canal, and Fort Brady is within half a mile.

Money statement.

Amount estimated for fiscal year ending June 30, 1895		$63,000.00
Balance remaining from allotment of preceding year, exclusive of outstanding liabilities	$16,401.30	
Outstanding liabilities, partly known and partly estimated	4,300.00	
		12,101.30
Additional allotment required for fiscal year ending June 30, 1895		50,898.70

Appropriations for operating and care of St. Marys Falls Canal, Michigan.

Expended during fiscal year ending June 30—	
1882	$31,207.48
1883	35,509.70
1884	31,212.93
1885	27,242.45
1886	25,400.95
1887	22,138.92
1888	29,898.72
1889	30,749.45
1890	$34,323.85
1891	48,330.89
1892	61,389.74
1893	42,412.12
1894	55,213.09
Total	475,030.29

Statement of receipts and expenditures at St. Marys Falls Canal during the fiscal year ending June 30, 1894.

Receipts:		
Balance at close of fiscal year ending June 30, 1893	$17,915.66	
Allotted July 5, 1893	45,217.70	
Allotted June 22, 1894	50,898.70	
		$114,032.06
Expenditures:		
Office expenses	313.83	
General purchases	2,179.76	
Repairs	10,598.02	
Labor, operating, and care	39,096.05	
Extra labor	1,511.80	
Lights on lock	1,513.63	
		55,213.09
Balance at close of fiscal year ending June 30, 1894		58,818.97

Net cost of operating and care of canal, $55,213.09. Net cost includes all repairs and improvements made by the operating and care force and labor party and the purchases therefor.

REPORT OF COL. O. M. POE, CORPS OF ENGINEERS, ON COMMERCE PASSING ST. MARYS FALLS CANAL DURING 1893.

[Printed in House Ex. Doc. No. 49, Fifty-third Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., December 13, 1893.

GENERAL: I have the honor to submit the following report upon and statistics of the commerce passing St. Marys Falls Canal during the season of 1893, just closed, together with a comparison between the business of 1892 and that of 1893.

The season opened May 1 and closed at 6:50 p. m., December 5. Therefore the canal was open to navigation 219 days, or 14 days less than in 1892.

The average number of craft of all kinds passing per day was 54.83 as against 54 for 1892, an increase of somewhat more than 1½ per cent. The daily average of registered craft in 1893 was 51.8 as against the same average in 1892.

The total number of passing vessels of all kinds was less by 572 than in 1892, a decrease of nearly 5 per cent. The total number of registered vessels was less by 727 than in 1892, a decrease of 6 per cent.

There was a decrease of 417,761 tons, or 4 per cent, in the freight tonnage, and a decrease of 797,449 tons, or 7 per cent, in the registered tonnage. This lesser rate of decrease in the freight tonnage was principally due to the slightly better average stage of water and to an increase in the amount of coal, which is entirely an up-bound freight.

The average registered tonnage of the vessels passing in 1893 was almost exactly 869 tons as against 882.6 tons in 1892, a decrease of a little more than 1½ per cent. The average tonnage of freight per registered vessel was 952.7 tons as against 929.8 tons in 1892, an increase of 2.6 per cent.

The items coal, flour, wheat, grain (other than wheat), copper, lumber, and silver ore all show an increase over the same items in 1892, the grain being largely in breadstuffs; while the items vessels, lockages, registered tonnage, freight tonnage, manufactured and pig iron, salt, iron ore, building stone, and unclassified freight show losses, the principal decrease being in iron ore.

As in 1892, the item "unclassified freight" was almost exactly 4 per cent of the total freight.

While several items of freight show a decrease as stated above, yet there is a decided increase in others, especially in the more valuable commodities, and, altogether, the traffic proves to have been much more satisfactory in total results than was anticipated earlier in the season. Indeed, it happened that the traffic during the month of July was the heaviest in the history of the canal, amounting, as it did, to more than 2,000,000 tons of freight for the first time in any month.

The value of the freight passing the canal during the season of 1893, using the same unit values as in 1892, aggregated $145,435,956.94 as against $135,117,267.10 in 1892, an increase of $10,319,689.84, or more than 7.6 per cent.

A tracing* is transmitted herewith showing the available depth of water in the canal during the last five seasons.

I am, general, very respectfully, your obedient servant,

O. M. POE,
Colonel, Corps of Engineers,
Bvt. Brig. Gen., U. S. A.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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*Not reprinted; printed in House Ex. Doc. No. 49, Fifty-third Congress, second session.

Comparative statement of the amount and value of commerce through St. Marys Falls Canal, Michigan, for the calendar years 1892 and 1893.

Items.	Quantity.		Increase.		Decrease.	
	1892.	1893.	Amount.	Per cent.	Amount.	Per cent.
Vessels * ... number	12,580	12,008			572	5
Lockages ... do	5,867	5,553			314	6
Tonnage:						
Registered ... net tons	10,647,203	9,849,754			797,449	7
Freight ... do	11,214,333	10,796,572			417,761	4
Passengers ... number	25,896	18,869			7,027	27
Coal (hard and soft) ... net tons	2,904,266	3,008,120	103,854	4		
Flour ... barrels	5,418,135	7,420,674	2,002,539	37		
Wheat ... bushels	40,994,780	43,481,652	2,486,872	6		
Grain (other than wheat) ... do	1,666,690	2,405,344	738,654	44		
Manufactured iron ... net tons	59,772	57,046			2,726	5
Pig iron ... do	41,748	32,406			9,342	22
Salt ... barrels	275,740	228,730			47,010	17
Copper ... net tons	64,993	87,530	22,537	35		
Iron ore ... do	4,901,132	4,014,556			886,576	18
Lumber ... M feet, B. M	512,844	588,545	75,701	15		
Silver ore and bullion ... net tons	1,930	2,470	540	28		
Building stone ... do	39,698	19,426			20,272	51
Unclassified freight † ... do	459,146	415,180			43,966	10

Items.	Total valuation.		
	Price per unit.	1892.	1893.
Vessels * ... number			
Lockages ... do			
Tonnage:			
Registered ... net tons			
Freight ... do			
Passengers ... number			
Coal (hard and soft) ... net tons	$3.50	$10,164,931.00	$10,528,420.00
Flour ... barrels	4.00	21,672,540.00	29,682,696.00
Wheat ... bushels	.75	30,746,085.00	32,611,239.00
Grain (other than wheat) ... do	.56	933,346.40	1,346,992.64
Manufactured iron ... net tons	50.00	2,988,600.00	2,852,300.00
Pig iron ... do	17.00	709,716.00	550,902.00
Salt ... barrels	1.00	275,740.00	228,730.00
Copper ... net tons	200.00	12,998,600.00	17,506,000.00
Iron ore ... do	3.50	17,153,962.00	14,050,946.00
Lumber ... M feet, B. M	18.09	9,231,192.00	10,593,810.00
Silver ore and bullion ... net ton	153.79	296,814.70	379,861.30
Building stone ... do	10.00	396,980.00	194,260.00
Unclassified freight † ... do	60.00	27,548,760.00	24,910,800.00
Total		135,117,267.10	145,436,956.94

* Steamers	8,379
Sails	2,955
Unregistered craft	674
Total	12,008

† Included in unclassified freight for 1893: Wool, 327 tons; and hides, 212 tons.

Canal was open to navigation during the season of—	Days.
1892	233
1893	219

Valuation for—	
1885	$53,413,472.13
1886	69,080,071.95
1887	79,031,757.78
1888	82,156,019.97
1889	83,732,527.15
1890	102,214,948.70
1891	128,178,208.51
1892	135,117,267.10
1893	145,436,956.94

NOTE.—The price per unit is based on the values used in 1885 with the exception of the items of flour, wheat, and grain, for which a new valuation was adopted in 1892. Average value per ton of freight, $13.47.

DISCUSSION OF STATISTICS OF COMMERCE OF ST. MARYS FALLS CANAL FOR SEASON OF 1893.

[Printed in House Ex. Doc. No. 224, Fifty-third Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., May 12, 1894.

GENERAL: I have the honor to submit the following discussion of statistics connected with operating and care of St. Marys Falls Canal, Michigan, during the season of 1893. The deductions are similar to those submitted each year since 1887. The prime object has been, as usual, to obtain the cost of carrying a ton of freight 1 mile, taking as a basis the entire traffic to and from Lake Superior which passed through the canal during the season and was reported in proper form to the management.

The methods used to obtain the result were the same as in prior years. They have been given in former reports in minute detail, and therefore are not now repeated.

Through the active interest of the Lake Carriers' Association the replies of shippers, owners, and managers to our requests for information concerning items and quantities of freight carried and rates received therefor have been much more general and complete than heretofore. It is believed that we have now attained a close approximation to accuracy, and that the results embodied in the following tables are entitled to a high degree of confidence.

The data received, as well as those afforded by the canal records, were compiled by the regular office force, assisted by the assistant superintendents of the canal, who were assigned to this duty after the close of navigation. The compilation was under the immediate supervision of Office Watchman John McMahon.

The following data were obtained from the canal records. The ton referred to is the net ton of 2,000 pounds:

Total mile tons		8,980,310,240
Average distance freight was carried ... miles		831.9
Registered craft using canal during the season:		
Steamers	459	
Sail vessels and barges	294	
		753
Unregistered craft		213
Total freight carried by registered craft ... tons		10,757,237
Total freight carried by unregistered craft ... do		39,335
Total passengers		18,869
Total value of registered craft		$41,133,100
Total freight carried by Canadian vessels ... tons		444,045

AMERICAN CRAFT.

Class.	Number.	Registered tonnage.	Freight tonnage.	Passengers.	Valuation of vessels.
Steamers	420	387,737	7,364,479	9,813	$32,154,900
Sail	272	170,987	2,978,170	....	6,862,500
Total	692	558,724	10,342,649	9,813	39,017,400

CANADIAN CRAFT.

Class.	Number.	Registered tonnage.	Freight tonnage.	Passengers.	Valuation of vessels.
Steamers	39	20,420	358,674	9,056	1,907,200
Sail	22	9,019	55,914	....	208,500
Total	61	29,439	414,588	9,056	2,115,700

FREIGHT CARRIED BY UNREGISTERED CRAFT.

Class.	Number of passages.	Freight tons.	Average per passage.
American	156	9,878	$63\frac{641}{2000}$
Canadian	57	29,457	$516\frac{1}{2}\frac{578}{2000}$
Total	213	39,335	....

The total freight carried by American unregistered craft amounted to 9,878 tons in 156 passages, making an average of $63\frac{641}{2000}$ tons of freight per passage.

The total freight carried by Canadian unregistered craft amounted to 29,457 tons in 57 passages, making an average of $516\frac{1}{2}\frac{578}{2000}$ tons of freight per passage.

The Canadian freight was 4.1 per cent of the total freight for the season.

The total passages for the season amounted to 12,008, and 1,632 of these were by 86 craft under 100 tons register; their aggregate registered tonnage was 2,494, and their average tonnage 29 tons.

The freight carried during the season by these craft only amounted to 762 tons.

The following tables were compiled from the replies received in response to inquiries addressed to those engaged in transportation through the canal:

Table No. 1 shows the through freight rates on commodities for the season, the last line showing the average for each. In this table due weight is given to the distances freight was carried. The nature of the data from which the table was compiled is such that they necessarily include all charges of every kind.

Table No. 2 shows the total freight cost on each commodity, the factors being the whole amount carried of each, and the average charge per unit as given in Table No. 1. It also gives the aggregate amount paid for freight on all the commodities.

Table No. 3 shows for each season from 1887 (inclusive) the average freight rates per voyage on each of the listed commodities, the total cost of transportation, the average length of voyages, and the rate per ton per mile.

TABLE No. 1.—*Freight rates on articles of commerce for season of 1893.*

Merchandise (per ton).	Coal (per ton).	Flour (per barrel).	Wheat (per bushel).	Corn (per bushel).	Grain (per bushel).	Manufactured iron (per ton).	Pig iron (per ton).	Salt (per barrel).	Copper (per ton).	Iron ore (per ton).	Lumber (per M feet, B. M.).	Silver ore (per ton).	Buildingstone (per ton).
	Cents.	*Cents.*	*Cents.*	*Cents*	*Cents.*			*Cents.*		*Cents.*			
	15		$2\frac{1}{8}$							85			
	45									70			
	40									76			
	52		$2\frac{7}{10}$							58	$2.07		
					$2\frac{3}{4}$					84			
	35									69			
	40									79			
	48								$1.07		2.04		
	37		$3\frac{3}{10}$		$2\frac{1}{2}$					83	3.19		
$3.45							$1.35		2.23		2.50		
											2.00		
2.29	50	$17\frac{1}{2}$	$2\frac{1}{4}$			$1.45	1.28	12					$1.36
	42									91			
											2.25		

TABLE No. 1.—*Freight rates on articles of commerce for season of 1893*—Continued.

Merchandise (per ton).	Coal (per con).	Flour (per barrel).	Wheat (per bushel).	Corn (per bushel).	Grain (per bushel).	Manufactured iron (per ton).	Pig iron (per ton).	Salt (per barrel).	Copper (per ton.)	Iron ore (per ton).	Lumber (per M feet, B. M.	Silver ore (per ton).	Building stone (per ton.)
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*			*Cents.*		*Cents.*			
	39½		$2\frac{89}{100}$							83			
	45									92			
	41									81			
	30		2¾							80			
											$1.68		
	45		2⅛							85			
	48										2.96		
	42		3⅛							88	2.50		
	40									80			
	58											$2.25	
	45												
	34½		2½							77			
	40		2							58			
	31		2⅛							66			
	40									90			
	40		2⅜							79			
	38	12½	2¼							76			
											2.05		
	60		4⅛										
	61		3⅜										
	35										2.31		
	$37\frac{1}{10}$		$2\frac{9}{10}$							77			
	30		3½					12½			2.38		
	52½		3	2½	3					65			
$3.00	25	25				$3.00			$1.90				
	45									76	2.25		
	$40\frac{7}{10}$	12½	$2\frac{3}{10}$	$2\frac{4}{10}$	2¾					68			
	41		$2\frac{79}{100}$							86			
3.00	40	17	$2\frac{8}{10}$	$2\frac{5}{10}$	2¾	2.00	$1.30	12	1.75	80	2.35	2.25	$1.36

TABLE No. 2.—*Mile-tons, season of 1893.—Cost of carrying freight transported through the St. Marys Falls Canal.*

Items.	Unit.	Quantity.	Price per unit.	Amount.
Coal	Net ton	3,008,120	$0.40	$1,203,248.00
Flour	Barrel	7,420,674	.17	1,261,514.58
Wheat	Bushel	43,481,652	$.02\frac{8}{10}$	1,217,486.26
Grain, other than wheat	...do	2,405,344	.02¾	66,146.96
Manufactured iron	Net ton	57,046	2.00	114,092.00
Pig iron	...do	32,406	1.30	42,127.80
Salt	Barrel	228,730	.12	27,447.60
Copper	Net ton	87,530	1.75	153,177.50
Iron ore	...do	4,014,556	.80	3,211,644.80
Lumber	M feet, B.M.	588,545	2.35	1,383,080.75
Silver ore and bullion	Net ton	2,470	2.25	5,557.50
Building stone	...do	19,426	1.36	26,419.36
Miscellaneous merchandise	...do	415,180	3.00	1,245,540.00
				9,957,483.11

NOTE.—The total amount paid for freight was $9,957,483.11; which divided by the total mile tons (8,980,310,240) gives the cost per mile per ton as $1\frac{1}{10}$ mills.

The average distance freight was carried was $831\frac{9}{10}$ miles, which was $9\frac{5}{10}$ miles greater than in 1892.

TABLE NO. 3.—*Cost of transportation.—Freight rates on articles of commerce through St. Marys Falls Canal for seasons indicated.*

Year.	Coal (per net ton).	Flour (per barrel).	Wheat (per bushel).	Grain (per bushel).	Corn (per bushel).	Oats (per bushel).	Manufactured iron (per net ton).	Pig iron (per net ton).	Salt (per barrel).	Copper (per net ton).	Iron ore (per net ton).	Lumber (per M feet, B. M.).	Silver ore (per net ton).	Building stone (per net ton).	General merchandise (per net ton).
	Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*	*Cents.*			*Cents.*						
1887..	90	29	(*)	7	(*)	(*)	$2.35	(†)	18	$2.60	$1.75	$4.00	$3.00	$1.15	$4.00
1888..	70	17½	3⅛	(‡)	4⅓	5	1.80	$1.30	16	2.35	1.28	2.80	1.90	2.05	3.00
1889..	47	18	4	3¼	(*)	(*)	2.10	1.45	18	2.25	1.14	2.70	1.90	2.02	3.00
1890..	45	13	3	......	3	2	1.34	1.35	15	2.38	1.10	2.38	2.25	2.00	2.75
1891..	43	15	$4\frac{6}{10}$	3½	(*)	(*)	2.50	1.17	18	2.00	.98	2.70	2.25	2.00	3.58
1892..	41	16½	$3\frac{6}{10}$	3¾	(*)	(*)	2.15	1.23	15	1.40	1.00	2.95	2.25	1.67	3.60
1893..	40	17	$2\frac{5}{10}$	2¾	2½	(*)	2.00	1.30	12	1.75	.80	2.35	2.25	1.36	3.00

Year.	Total cost of transportation.	Average distance freight was carried.	Cost of transportation per mile ton.
		Miles.	*Mills.*
1887	$10,075,153.13	811.4	2.3
1888	7,883,077.40	806.9	1.5
1889	8,634,246.63	790.4	1.5
1890	9,472,214.90	797.2	1.3
1891	9,849,022.81	820.4	1.35
1892	12,072,850.88	822.4	1.31
1893	9,957,483.11	831.9	1.1
Yearly average distance freight was carried	....	811.5	....

* Included in grain. † Included in manufactured iron. ‡ Included in corn and oats.

From the canal records it was further ascertained that there were 91 propellers that carried in their largest load 2,000 tons and upward; that these 91 cargoes aggregated 204,709 tons, and averaged 2,250 tons. There were 31 propellers that carried in their largest load 2,500 tons and upward, aggregating 82,999 tons, and averaged 2,677 tons; and 14 propellers that carried in their largest load 3,000 tons and upward, aggregating 45,964 tons, and averaged 3,283 tons. There were 12 sail vessels and barges that carried 2,000 tons and upward, aggregating 26,007 tons, and averaged 2,167 tons; 20 sail vessels and barges that carried 2,500 tons and upward, aggregating 55,743 tons, and averaged 2,787 tons; and 1 (barge) that carried 3,000 tons and upward, aggregating 63,152 tons, and averaged 3,007 tons.

The greatest number of miles run during the season is to the credit of the propeller *Matoa*, of the Minnesota Steamship Line, of Cleveland, Ohio, and amounted to 42,939 miles.

The greatest amount of freight carried during the season is to the credit of the propeller *Mariposa* of the same line, aggregating 87,760 tons.

The greatest number of miles-tons for the season is to the credit of the same boat, and is 73,086,136.

The largest single cargo carried during the season is to the credit of the propeller *Selwyn Eddy*, of Bay City, Mich., and amounted to 3,686 net tons.

The largest single cargo carried by a sail vessel (a barge) is to the credit of the Huron Barge Company's tow barge *Sagamore*, and amounted to 3,232 net tons. This barge earned the same credit during the season previous.

The canal was open to navigation during the season of 1893 two hundred and nineteen days, which is a decrease of fourteen days in comparison with 1892. The amount of freight carried during the season of 1893 amounted to 10,796,572 tons, which is a decrease of 417,761 net tons, or 3.73 per cent, in comparison with the season of 1892.

It is found, by the discussion of the reports of the watchmen stationed at the head and foot of the canal, that vessels were delayed at the canal during the season thirty-seven thousand eight hundred and seventy-seven hours and seventeen minutes, or an average of three hours and fifteen minutes. These records also show that vessels were detained nine minutes by the railroad swing bridge being closed, and that the closing of the bridge was only delayed by boats five hours and twenty-four minutes.

All of which is respectfully submitted.

O. M. Poe,
Colonel, Corps of Engineers,
Bvt. Brig. Gen., U. S. A.

Brig. Gen. Thomas L. Casey,
Chief of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Comparative statement of traffic through St. Marys Falls Canal for fiscal years ending June 30, 1893, and 1894.

Items.	1893.	1894.	Increase.		Decrease.	
			Amount.	Per cent.	Amount.	Per cent.
Vessels .... number..	12,160	13,011	851	7	....	.....
Lockages .... do....	5,611	6,065	454	8	....	.....
Tonnage:						
Registered .... net tons..	10,225,977	11,066,168	840,191	8	....	.....
Freight .... do....	10,846,404	11,158,992	312,588	3	....	.....
Passengers .... number..	23,919	20,840	....	.....	3,079	13
Coal .... net tons..	2,771,667	2,372,406	....	.....	399,261	15
Flour .... barrels..	5,627,778	8,281,853	2,654,075	47	....	.....
Wheat .... bushels..	40,959,960	34,447,963	....	.....	6,511,997	16
Grain, other than wheat .... do....	2,446,159	2,456,992	10,833	.....	....	.....
Manufactured and pig iron... net tons..	97,291	89,078	....	.....	8,213	8
Salt .... barrels..	251,028	223,602	....	.....	27,426	11
Copper .... net tons..	73,606	90,466	16,860	23	....	.....
Iron ore .... do....	4,668,807	5,085,422	416,615	9	....	.....
Lumber .... M feet, B. M..	620,531	644,521	23,990	4	....	.....
Silver ore .... net tons..	1,955	2,427	472	24	....	.....
Building stone .... do....	47,176	17,294	....	.....	29,882	63
Unclassified freight .... do....	371,350	426,321	54,971	15	....	.....

Statement of the number of vessels passed through St. Marys Falls Canal, with number and cost of lockages, for fiscal year ending June 30, 1894.

Vessels	13,011		
Lockages	6,065		
Registered tonnage	11,066,168		
Freight tonnage	11,158,992		
	Hrs.	Min.	Sec.
Total time during which lock was operated	4,002	6	00
Average time occupied in making a lockage		39	36
Total time spent by vessels in the lock	7,199	50	00
Average time spent by vessels in passing lock		33	12
Cost per lockage			$9.10
Cost per vessel			4.24
			Mills.
Cost per registered ton			4.99
Cost per freight ton			4.95

The canal was open to navigation two hundred and thirty-five days during the fiscal year.

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, for the fiscal year ending June 30, 1894.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Part of month of July, 1893.		
1893. June 12	6	W. J. Murray	Handling and carting from U. S. Engineer Office, 34 West Congress street, to the Western Transit Co.'s dock, Detroit, Mich., 8 boxes stationery, 1 bundle baskets, 1 bundle wrapping paper, 1 bundle paper tubes, weighing 1,240 pounds.	$2.00
30	7	C. S. Osborn, P. M	Rent of post-office box 146 for the quarter ending June 30, 1893.	1.00
30	8	Board of public works, by F. M. Taylor, deputy register.	Water rent for second quarter, 1893, from Apr. 1 to June 30, 1893, (both dates inclusive), at $9 per year.	2.25
30	9	Telephone and Telegraph Construction Co., Hugh McMillan, treasurer.	Rent of telephone for three months, from Apr. 1, 1893, to June 30, 1893 (both dates inclusive), at $48 per year.	12.00
July 12 15	10	O. M. Poe, Col., Corps of Engineers, etc.	Mileage from Detroit, Mich., to Sault Ste. Marie, Mich., and return, 896 miles, at 8 cents per mile.	51.88
		Month of August, 1893.		
Aug. 3	1 and 2	Pay rolls, July, 1893	1 superintendent, 24 days, at $150 per month.	120.00
			1 superintendent, 6 days, at $150 per month.	30.00
			2 assistant superintendents at $100 per month.	200.00
			1 assistant superintendent, 24 days, at $100 per month.	80.00
			1 assistant superintendent, 6 days, at $100 per month.	20.00
			1 clerk	150.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			4 foremen, at $75 per month	300.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			2 watchmen, at $45 per month	90.00
			3 lockmen, at $60 per month	180.00
			3 lockmen, at $50 per month	150.00
			21 lockmen, 20 months and 10½ days, at $45 per month.	915.75
			13 laborers, 12 months and 5¼ days, at $45 per month.	547.88
			1 carpenter, 25 days, at $2.50 per day	62.50
			2 stonecutters, 2 days, at $4.30 per day	8.60
			1 scrubber, 16¼ days, at $1.20 per day	19.50
July 28	3	Emery D. Weimer	3,648 feet, B. M., lumber, white pine, 3 by 12 inches by 19 feet, at $18.50 per M feet $67.49	
			5,256 feet, B. M., lumber, white pine, 2 by 12 inches by 12 feet, at $16.75 per M feet 88.04	
			5,300 feet, B. M., lumber, white pine, 2 by 10 inches by 12 feet, at $15.75 per M feet 83.47	
			97,920 feet, B. M., lumber, white pine, 12 by 12 inches by 32 feet, at $23.25 per M feet 2,276.64	
			44,280 feet, B. M., lumber, white pine, 12 by 12 inches by 30 feet, at $23 per M feet 1,018.44	
			36,960 feet, B. M., lumber, white pine, 12 by 12 inches by 28 feet, at $22.50 per M feet 831.60	
			31,824 feet, B. M., lumber, white pine, 12 by 12 inches by 26 feet, at $22.25 per M feet 708.03	
			94,752 feet, B. M., lumber, white pine, 12 by 12 inches by 24 feet, at $22 per M feet 25084.54	
			22,320 feet B. M., lumber, white pine, 12 by 12 inches by 20 feet, at $21 per M feet 468.72	
			56,832 feet, B. M., lumber, white pine, 12 by 12 inches by 16 feet, at $20 per M feet 1,136.64	

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased	Articles.		Amount.
		Month of August, 1893—Continued.			
1893. July 28	3	Emery D. Weimer	4,761 feet, B. M., lumber, white oak, common, good, at $24.75 per M feet	$117.83	
			51 pieces white oak, round, 16 inches in diameter, 8 feet long, at $5 each	255.00	
			2,000 feet, B. M., maple flooring, at $31.25 per M feet	62.50	
				9,198.99	
			Less 10 per cent retained.	919.90	
					$8,279.09
Aug. 14	4	P. M. Church & Co.	3,036 bolts, iron, 34 inches long, 1 inch diameter, 22,739 pounds, at 2⅕ cents per pound.		500.26
			2,028 bolts, iron, 22 inches long, 1 inch diameter, 10,110 pounds, at 2⅕ cents per pound.		222.42
			5 dozen brooms, at $3.50 per dozen		17.50
			3 only brushes, varnish, at 50 cents each.		1.50
			2 dozen brushes, scrub, at $1 per dozen		2.00
			2 sets brushes for dynamo, at $2 per set		4.00
			2 pairs calipers, at $1 per pair		2.00
			¼ gross chalk, carpenters', at 75 cents per gross.		.19
			50 pounds charcoal, at 1½ cents per pound.		.75
			100 feet chain, 125 pounds, at 12½ cents per pound.		15.63
			3 dozen chimneys, student's lamp, at 75 cents per dozen.		2.25
			2 dozen chimneys, Rochester lamp, at 75 cents per dozen.		1.50
			6 dozen chimneys, head light, at $1.35 per dozen.		8.10
			15 yards cloth, oil, at 35 cents per yard		5.25
			50 yards cloth, sail, at 30 cents per yard		15.00
			2 yards cloth, gum, at $1.25 per yard		2.50
			1 yard cloth, rubber		2.00
			50 yards cloth, cotton, at 12 cents per yard.		6.00
			8 only dusters, at 50 cents each		1.50
			1 only duster, paint		.60
			10 gallons dryer, Japan, at 65 cents per gallon.		6.50
			4 only elbows, at 25 cents each		1.00
			1 dozen files, 5 inch		.68
			1 dozen files, 8-inch		1.16
			1 dozen files, 14-inch		3.12
			200 pounds felt, tarred, at 1¾ cents per pound.		3.50
			½ dozen faucets, at $6 per dozen		3.00
			1 only grating		7.50
			1 box glass, window, 11 by 14 inches		4.00
			1 box glass, window, 16 by 28 inches		5.00
			1 box glass, window, 16 by 22 inches		4.00
			1½ dozen globes, lantern, at 60 cents per dozen.		.90
			5 pounds glycerin, at 30 cents per pound.		1.50
			2 dozen handles, file, at 20 cents per dozen.		.40
			2 dozen handles, ax, at $2 per dozen		4.00
			2 dozen handles, sledge, at $1.50 per dozen.		3.00
			1 dozen handles, crosscut saw		2.16
			3 only hammers, claw, at 50 cents each		1.50
			50 feet hose, steam, at 99 cents per foot		49.50
			½ dozen holders, carbon, at $15 per dozen.		7.50
			1 only indicator, speed		1.50
			4 barrels lime, at $1.25 per barrel		5.00
			4 cases lye, concentrated, at $2.60 per case.		10.40
			20 square feet leather, lace, at 18 cents per square foot.		3.60
			½ dozen lanterns, at $12 per dozen		6.00
			1 set mica		2.00
			3 pounds metal polish, at 35 cents per pound.		1.05
			10 pounds marline, at 13 cents per pound.		1.30
			1 case matches		2.00
			1 pair mittens, diver's		5.00
			1 keg nails, wrought		6.00

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of August, 1893—Continued.		
1893. Aug. 14	4	P. M. Church & Co.	524 gallons oil, kerosene, at 8 cents per gallon.	$41.92
			49¼ gallons oil, mineral seal, at 14 cents per gallon.	6.89
			1 gallon oil, sperm	2.00
			1 barrel ocher, yellow, 350 pounds, at 1¼ cents per pound.	4.37
			3½ pounds packing, at 70 cents per pound.	2.45
			68 pieces packing, leather, at $2.20 each.	149.60
			61 pounds packing, hemp, at 15 cents per pound.	9.15
			20½ pounds packing, composition, at 60 cents per pound.	12.30
			50 pounds packing, rubber, at 15 cents per pound.	7.50
			10 joints stove pipe, at 35 cents per joint.	3.50
			500 feet gas pipe, at 9 cents per foot	45.00
			2 only pots, fire, 70 pounds, at 10 cents per pound.	7.00
			1 only puller, nail	1.75
			5 dozen sheets paper, emery, at 10 cents per dozen.	.50
			50 pounds putty, at 2½ cents per pound	1.25
			½ pound points, glaziers', at 30 cents per pound.	.15
			½ dozen rakes, garden, at $4.80 per dozen.	2.40
			293 pounds rope, at 9¾ cents per pound	28.57
			23¼ pounds rope, hemp, at 25 cents per pound.	5.81
			2 only grindstones, at $2.25 each	4.50
			¼ dozen shades, lamp, at $2.16 per dozen.	.54
			2 dozen shovels, at $6 per dozen	12.00
			¼ dozen shovels, scoop, at $9 per dozen	2.25
			1 dozen stones, scythe	.50
			3 only saws, timber, at $2 each	6.00
			3 kegs spikes, cut, at $1.75 per keg	5.25
			3 kegs spikes, wrought, at $5.70 per keg.	17.10
			6 packages screws, wood, at 44 cents per package	2.64
			1 only scale	14.00
			3 cases soap, at $4.50 per case	13.50
			10 barrels salt, at $1.25 per barrel	12.50
			1 only strainer, paint	1.00
			5 pounds sienna, raw, at 15 cents per pound	.75
			5 pounds sienna, burnt at 15 cents per pound.	.75
			2 sets segments, at $4 per set	8.00
			10 gallons turpentine, at 50 cents per gallon.	5.00
			2 packages japo okonite, at 75 cents per package.	1.50
			3 feet tubing, rubber, at 50 cents per foot.	1.50
			1½ dozen unions, at $2.75 per dozen	4.13
			10 pounds ultramarine blue, at 25 cents per pound.	2.50
			5 pounds umber, at 15 cents per pound	.75
			1 only wrench	1.50
			1 only wrench, pipe	10.00
			224 pounds waste, at 9 cents per pound	20.16
			2 yards wicking, at 3 cents per yard	.06
			2,000 pounds white lead, at 7 cents per pound.	140.00
		Month of September, 1893.		
Sept. 5	1 and 2	Pay rolls, August, 1893	1 superintendent	150.00
			1 assistant superintendent	100.00
			2 assistant superintendents, 16 days, at $100 per month.	106.66
			2 assistant superintendents, 14 days, at $100 per month.	93.34
			1 clerk	150.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			3 foremen, at $75 per month	225.00
			1 foreman, 29 days, at $75 per month	72.50

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of September, 1893—Continued.		
1893. Sept. 5	1 and 2	Pay rolls, August, 1893	1 watchman	$75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			2 watchmen, at $45 per month	90.00
			3 lockmen, 2 months and 29 days, at $60 per month.	178.00
			3 lockmen, 2 months and 29 days, at $50 per month.	148.33
			20 lockmen, 19 months and 27 days, at $45 per month.	895.50
			21 laborers, 16 months and 6 days, at $45 per month.	729.00
			2 laborers, 6⅕ days, at $1.50 per day	9.30
			2 divers, 2 days, at $7.50 per day	15.00
			3 machinists, 37⅘ days, at $2.50 per day	94.50
			1 carpenter, 27 days, at $2.50 per day	67.50
			1 scrubber, 17½ days, at $1.20 per day	21.00
Aug. 29	3	Emery D. Weimer	1,152 feet, B. M., 12 by 12 inch. by 16 foot white pine lumber, at $20 per M.	23.04
			1,920 feet, B. M., 12 by 12 inch. by 20 foot white pine lumber, at $21 per M.	40.32
			2,160 feet, B. M., assorted white oak lumber, at $24.75 per M.	53.46
			2,363 feet, B. M., 3 by 6 inch. by 21 foot Norway pine, at $24.50 per M.	57.89
			For 10 per cent retained as per voucher 3, August, 1893.	919.90
		Month of October, 1893.		
Sept. 30	1	Justin E. Smith	Rent of storeroom at Detroit, Mich., from July 1 to Sept. 30, 1893, both days inclusive, being 3 months, at $10 per month.	30.00
June 23	2	The Richmond & Backus Co., Charles F. Backus, secretary and treasurer.	1,000 sheets of paper, plain T. W., 8 by 12½ inches.	4.50
			1,000 sheets of paper, manufactured T. W., 8 by 12½ inches.	2.00
Oct. 5	3 and 4	Pay rolls, September, 1893	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			4 foremen, at $75 per month	300.00
			1 watchman, 22 days, at $75 per month	$55.00
			1 watchman	55.00
			3 watchmen, 2 months and 19 days, at $50 per month.	131.67
			2 watchmen, at $45 per month	90.00
			3 lockmen, 2 months and 29 days, at $60 per month.	178.00
			3 lockmen, 2 months and 25½ days, at $50 per month.	142.50
			20 lockmen, 19 months and 11 days, at $45 per month.	871.50
			23 laborers, 20 months and 6 days, at $45 per month.	909.01
			2 divers, 5½ days, at $7.50 per day	41.25
			1 stonecutter, 5 days, at $4.30 per day	21.50
			1 blacksmith, 3$\frac{13}{60}$ days, at $3 per day	9.65
			2 machinists, 22 days, at $2.50 per day	55.00
			1 carpenter, 26 days, at $2.50 per day	65.00
			1 scrubber, 17½ days, at $1.20 per day	21.00
Sept. 30	5	Edison Sault Electric Co., by Samuel G. Carleton, bookkeeper.	Electric current for 22 arc lamps for month of July, 1893, at $6.50 each per month.	143.00
			Electric current for 30 arc lamps for month of August, 1893, at $6.50 each per month.	195.00
			Electric current for 31 arc lamps for month of September, 1893, at $6.50 each per month.	201.50
July 8	6	Postal Telegraph Cable Co., by H. J. Kinnucan, assistant superintendent.	Transmission of telegram on official business from Washington, D. C. to Detroit, Mich., containing 41 words.	.41

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
1893.		*Month of October, 1893*—Continued.		
Sept. 30	7	Telephone and Telegraph Construction Co., Hugh McMillan, treasurer.	Rental of telephone for 3 months, commencing July 1 and ending Sept. 30, 1893, both dates inclusive, at $40 per year.	$12.00
30	8	Board of Public Works, by F. M. Taylor, deputy register.	Water rent for third quarter, 1893, from July 1 to Sept. 30, 1893, both dates inclusive, at $9 per year.	2.25
Oct. 18	9	T. C. Anthony	60 tons coal, anthracite, at $6.70 per ton	402.00
			40 tons coal, Massillon, at $3.50 per ton	140.00
			6 tons coal, cannel, at $5.25 per ton	31.50
21	10	W. J. Magee	2 copies directory, city, at $3 per copy	6.00
1893.		*Month of November, 1893.*		
Nov. 4	1 and 2	Pay rolls, October, 1893	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			4 foremen, 3 months and 24 days, at $75 per month.	285.00
			1 watchman	75.00
			1 watchman	55.00
			4 watchmen, 3 months, at $50 per month.	150.00
			2 watchmen, at $45 per month	90.00
			3 lockmen, 2 months and 28½ days, at $60 per month.	177.00
			3 lockmen, at $50 per month	150.00
			19 lockmen, 18 months and 22 days, at $45 per month.	843.00
			21 laborers, 19 months and 22½ days, at $45 per month.	888.75
			1 driver, 1½ days, at $7.50 per day	11.25
			1 mason, 1½ days, at $3.50 per day	5.25
			2 machinists, 8¾ days, at $2.50 per day	21.88
			1 carpenter, 26 days, at $2.50 per day	65.00
			1 laborer, 1½ days, at $1.50 per day	2.25
			1 scrubber, 22¾ days, at $1.20 per day	27.30
Oct. 31	3	Fred. Poliguin	Services as laborer, from Oct. 1 to 31, 1893, both dates inclusive, being 1 month.	45.00
31	4	Edison Sault Electric Co., by Samuel G. Carleton, bookkeeper.	Electric current for 31 arc lamps for month of October, 1893, at $6.50 each per month.	201.50
Nov. 11	5	Union Iron Works Co., by Jas. C. Hardy, a member of the firm.	15 drums and 20 dogs, cast iron, with patterns for same.	197.00
		Month of December, 1893.		
Dec. 4	1 and 2	Pay rolls, November, 1893	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			4 foremen, at $75 per month	300.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			2 watchmen, at $45 per month	90.00
			3 lockmen, at $60 per month	180.00
			3 lockmen, 2 months and 27 days, at $50 per month	145.00
			19 lockmen, 19 months, at $45 per month.	855.00
			21 laborers, 20 months and 5 days, at $45 per month.	907.50
			2 laborers, 10⅔ days, at $1.50 per day	16.00
			2 divers, 3 days at $7.50 per day	22.50
			2 machinists, 26⅜ days, at $2.50 per day.	65.95
			1 carpenter, 26 days, at $2.50 per day	65.00
			1 scrubber, 16¼ days, at $1.20 per day	19.50
Nov. 18	3	P. M. Church & Co	1 stove, heating	14.00

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of December, 1893—Continued.		
1893. Dec. 5	4	Telephone and Telegraph Construction Co., Hugh McMillan, treasurer.	Rent of 3 telephones, from May 9 to Dec. 5, 1893, both dates inclusive, at $90 for the season of navigation—not to exceed 7 months.	$90.00
11	5	Edison Sault Electric Co., by Samuel G. Carleton, bookkeeper.	Electric current for 31 arc lamps, from Nov. 1 to 30, 1893, both dates inclusive, at $6.50 each per month.	201.50
			Electric current for 31 arc lamps, from Dec. 1 to 5, 1893, both dates inclusive, being one-sixth of a month, at $6.50 each per month.	33.58
			Electric current for 12 arc lamps, from Dec. 6 to 11, 1893, both dates inclusive, being one-fifth of a month, at $6.50 each per month.	15.60
		Month of January, 1894.		
27	1	Justin E. Smith	Furnishing one packing case and packing one pattern of guide pulley for gate cable lock of 1881.	1.00
31	2	Justin E. Smith	Rent of storeroom at Detroit, Mich., from Oct. 1 to Dec. 31, 1893, both dates inclusive, being 3 months, at $10 per month.	30.00
1894. Jan. 5	3 and 4	Pay rolls, December, 1893	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman	80.00
			1 engineman	75.00
			4 foremen, at $75 per month	300.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			2 watchmen, at $45 per month	90.00
			3 lockmen, 3 months, at $60 per month	180.00
			3 lockmen, 2 months and 23 days, at $50 per month.	138.33
			19 lockmen, 19 months, at $45 per month	855.00
			5 laborers, 3 months and 25½ days, at $45 per month.	173.25
			2 divers, 7 days, at $7.50 per day	52.50
			1 teamster with team, ⅝ day, at $4 per day	2.50
			2 machinists, 33$\frac{3}{25}$ days, at $2.50 per day	82.80
			1 scrubber, 17½ days, at $1.20 per day	21.00
1893. Dec. 27	5	American Express Co., by R. A. Catton, cashier, Detroit, Mich., office.	Express charges from Detroit, Mich., to Sault Ste. Marie, Mich., on 1 box containing wood pattern of guide pulley for gate cable lock, 1881, weighing 236 pounds, at $2.50 per 100 pounds.	5.90
Oct. 28– Nov. 15	6	The Richmond & Backus Co., by Chas. F. Backus, secretary and treasurer.	100 sheets paper (carbon) 500 envelopes (official), at $2 per M	3.50 1.00
Dec. 8	7	Postal Telegraph Cable Co., by H. J. Kinnucan, assistant superintendent.	Transmission of telegram, on official business, from Washington, D. C., to Detroit, Mich., 27 words.	.27
8–27	8	Western Union Telegraph Co., by M. S. Corbett, manager.	Transmission of telegrams on official business during the month of December, 1893.	1.33
15	9	P. M. Church & Co	¼ dozen 12-inch hack saws, at $12.68 per dozen.	3.17
			6 dozen extra blades, at $2.98 per dozen	17.88
1894. Jan. 1	10	Telephone and Telegraph Construction Co., Hugh McMillan, treasurer.	Rental of telephone from Oct. 1 to Dec. 31, 1893 (both dates inclusive), at $48 per year.	12.00
1893. Dec. 31	11	Board of public works, by F. M. Taylor, deputy recorder.	Water rent for fourth quarter, 1893; from Oct. 1 to Dec. 31, 1893 (both dates inclusive), at $9 per year.	2.25

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of February, 1894.		
1894. Feb. 3	1 and 2	Pay rolls, January, 1894	1 superintendent	$150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			1 engineman, 22 days, at $75 per month	55.00
			1 foreman	75.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			1 watchman	45.00
			3 machinists, 66 days, at $2.50 per day	165.00
			1 laborer, two-thirds of a day, at $1.50 per day.	1.00
			1 scrubber, 15 days, at $1.20 per day	18.00
		Month of March, 1894.		
Mar. 1	1	Pay rolls, February, 1894, office supervising engineer.	2 clerks, at $1.75 per month	350.00
			1 clerk	100.00
			1 copyist, $50; 1 copyist, $35	85.00
			1 office attendant	50.00
			1 messenger	50.00
			1 scrubber	7.50
2	2	Western Union Telegraph Co., by M. S. Corbett, manager.	Telegraphing, July 16, 1889, to June 16, 1891.	5.25
3	3 and 4	Pay rolls, February, 1894	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			1 foreman	75.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			1 watchman	45.00
			12 lockmen, 11 months and 26¼ days, at $45 per month.	534.38
			1 laborer	45.00
			1 laborer, 19 days, at $1.50 per day	28.50
			1 machinist, 4 days, at $2.50 per day	10.00
			1 teamster with team, one-half day, at $4 per day.	2.00
			1 scrubber, 18¾ days, at $1.20 per day	22.50
Feb. 28	5	E. S. Wheeler	For use of calculating machine, between Mar. 1, 1889, and Feb. 28, 1894; being 5 years, at $3.60 per year.	18.00
Mar. 17	6	Ferguson Hardware Co., by R. G. Ferguson, president.	For 402 turnbuckles for 1½-inch rods, at 48 cents each.	192.96
			404 washers, wrought iron, 10,058 pounds, at $3.10 per cwt.	311.80
			800 nuts, square, 1,360 pounds, at $3.35 per cwt.	45.56
			400 rods, 5 feet long, 1½ inches diameter, 11,710 pounds, at $2.10 per cwt.	245.91
		Month of April, 1894.		
31	1	Justin E. Smith	Rent of storeroom at Detroit, Mich., from Jan. 1 to Mar. 31, 1894 (both days inclusive), being 3 months, at $10 per month.	30.00
Apr. 4	2 and 3	Pay rolls, March, 1894	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 clerk	150.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			4 foremen, at $75 per month	300.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			2 watchmen, at $45 per month	90.00
			3 lockmen, at $60 per month	180.00
			3 lockmen, at $50 per month	150.00

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of April, 1894—Cont'd.		
1894. Apr. 4	2 and 3	Pay rolls, March, 1894	19 lockmen, 18 months and 27 days, at $45 per month.	$850.50
			4 laborers, 4 months, at $45 per month	180.00
			1 teamster with team, 6 days, at $4 per day.	24.00
			5 machinists, 116½ days, at $2.50 per day.	291.25
			2 calkers, 9½ days, at $2.50 per day	23.75
Mar. 5-17	4	The Richmond & Backus Co., by Chas. F. Backus, secretary and treasurer.	1 carpenter, 24 days, at $2.50 per day	60.00
			1 carpenter, 24 days, at $2 per day	48.00
			1 scrubber, 18¾ days, at $1.20 per day	22.50
31	5	Board of public works, by F. M. Taylor, deputy recorder.	100 sheets paper, carbon, 8 by 12½ inches	3.50
			500 sheets paper, manifold, 8 by 12½ inches, for typewriter, at $2 per M.	1.00
31	6	Telephone and Telegraph Construction Co., Hugh McMillian, treasurer.	Water rent for first quarter, 1894, from Jan. 1 to Mar. 31 (both dates inclusive), at $9 per year.	2.25
Apr. 14	7	The Richmond & Backus Co., by Chas. F. Backus, secretary and treasurer.	Rental of telephone from Jan. 1 to Mar. 31, 1894 (both dates inclusive), at $48 per year.	12.00
			1,000 blanks, contractors' estimates	12.00
			500 blanks, trans. vouchers for payment, at $7.25 per M.	3.63
			2,000 envelopesa, addressed Col. O. M. Poe, 4⅛ by 9½, 4 by 5⅞, at $3.10 per M.	6.20
			1,000 envelopes, official, 4⅛ by 9½	3.10
			1,000 envelopes, official, 3⅝ by 6	2.00
			1,000 envelopes, plain white, 3⅞ by 6	1.40
			250 envelopes, linen paper, at $3 per M	.75
			1,000 fasteners, McGill's No. 1	.85
			8 quarts ink, Carter's coal black, at 50 cents per quart.	4.00
			6 quarts ink, Faber's copying, at 50 cents per quart.	3.00
			2,000 sheets paper, writing, letter head, half sheets, ruled, at $4 per M.	8.00
			3,000 sheets paper, writing, letter, plain, half sheets, ruled, at $3.10 per M.	9.30
			5,000 sheets paper, writing, letter head, half sheets, unruled, at $3.60 per M.	18.00
			3,000 sheets paper, writing, letter, plain, half sheets, unruled, at $3 per M.	9.00
			1,000 sheets paper, writing, letter, plain, 8 by 12½, typewriter.	4.50
1893. July 28	8	Western Union Telegraph Co., by M. S. Corbett, manager.	2,000 sheets paper, writing, manifold, 8 by 12½, typewriter, at $2 per M.	4.00
1894. Apr. 19	9	George Freeborn	Transmission of telegram on official business, 22 words.	.22
		Month of May, 1894.	Two pieces oak timber (12 by 12 inches by 18 feet), 432 feet, at $50 per M. feet, B. M.	21.60
May 4	1 and 2	Pay rolls, April, 1894		
			1 superintendent, 1 month, at $150 per month.	150.00
			3 assistant superintendents, 3 months, at $100 per month.	300.00
			1 clerk, 1 month, at $150 per month	150.00
			1 engineman, 1 month, at $90 per month.	90.00
			2 enginemen, 2 months, at $80 per month.	160.00
			1 engineman, 1 month, at $75 per month.	75.00
			4 foremen, 4 months, at $75 per month	300.00
			1 watchman, 1 month, at $75 per month	75.00
			1 watchman, 1 month, at $55 per month	55.00
			3 watchmen, 3 months, at $50 per month.	150.00
			2 watchmen, 2 months, at $45 per month.	90.00
			3 lockmen, 3 months, at $60 per month	180.00
			3 lockmen, 2 months and 29½ days, at $50 per month.	149.17
			19 lockmen, 18 months and 29½ days, at $45 per month.	854.25
			22 laborers, 12 months and 2 days, at $45 per month.	543.00

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of May, 1894—Cont'd.		
1894. May 4	1 and 2	Pay rolls, April, 1894	1 diver, one-half day, at $7.50 per day	$3.75
			2 stonecutters, 11$\frac{7}{10}$ days, at $4.30 per day	50.00
			1 teamster, with team, 2 days, at $4 per day.	8.00
			1 machinist, 14⅘ days, at $2.50 per day	37.00
			1 carpenter, 25 days, at $2.50 per day	62.50
			1 carpenter, 25 days, at $2 per day	50.00
			2 calkers, 33 days, at $2.50 per day	82.50
			3 laborers, 19½ days, at $1.50 per day	29.25
			1 scrubber, 15 days, at $1.20 per day	18.00
Apr. 30	3	Edison-Sault Electric Co	Electric current for 33 arc lamps, from Apr. 18 to Apr. 30, 1894 (both dates inclusive), being 13 days, at $6.50 per month per lamp.	92.95
1893. Dec. 30	4	Ferguson Hardware Co	1 large Green River stock	5.64
			1 1½-inch right die and guide	8.80
			1 1½-inch left die and guide	11.28
		Month of June, 1894.		
1894. June 4	1 and 2	Pay rolls, May, 1894	1 superintendent, 1 month, at $150 per month.	150.00
			3 assistant superintendents, 3 months, at $100 per month.	300.00
			1 clerk, 27 days, at $150 per month	135.00
			1 engineman, 1 month, at $90 per month.	90.00
			2 enginemen, 2 months, at $80 per month.	160.00
			1 engineman, 1 month, at $75 per month.	75.00
			4 foremen, 4 months, at $75 per month	300.00
			1 watchman, 1 month, at $75 per month	75.00
			1 watchman, 1 month, at $55 per month	55.00
			3 watchmen, 3 months, at $50 per month.	150.00
			2 watchmen, 2 months, at $45 per month.	90.00
			3 lockmen, 3 months, at $60 per month	180.00
			3 lockmen, 2 months and 29½ days, at $50 per month.	149.17
			19 lockmen, 19 months, at $45 per month.	855.00
			29 laborers, 27 months and 19½ days, at $45 per month.	1,244.25
			1 diver, one-half day, at $7.50 per day	3.75
			1 teamster with team, 4½ days, at $3.50 per day.	15.75
			1 machinist, 9$\frac{1}{10}$ days, at $2.50 per day	22.75
			1 scrubber, 26¼ days, at $1.20 per day	31.50
May 31	3	Edison-Sault Electric Co	Electric current for 33 arc lamps, from May 1 to May 31, 1894 (both dates inclusive), being 1 month, at $6.50 per month per lamp.	214.50
9	4	Western Union Telegraph Company.	Telegram to Sault Ste. Marie, Mich., 20 words.	20
9			Telegram from Sault Ste. Marie, Mich., 20 words.	20
10			Telegram to Sault Ste. Marie, Mich., 20 words.	20
10	5	Postal Telegraph Cable Co	Telegram from Washington, D. C., to Detroit, Mich., 28 words.	28
		Month of July, 1894.		
July 3	1 and 2	Pay rolls, June, 1894	1 superintendent	150.00
			3 assistant superintendents, at $100 per month.	300.00
			1 engineman	90.00
			2 enginemen, at $80 per month	160.00
			1 engineman	75.00
			4 foremen, at $75 per month	300.00
			1 watchman	75.00
			1 watchman	55.00
			3 watchmen, at $50 per month	150.00
			2 watchmen, 1 month and 24 days, at $45 per month.	81.00
			3 lockmen, at $60 per month	180.00
			3 lockmen, 2 months and 29½ days, at $50 per month.	149.17
			19 lockmen, at $45 per month	855.00
			27 laborers, 26 months and 13 days, at $45 per month.	1,189.51
			1 diver, ½ day, at $7.50 per day	3.75

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite; applied to operating and care of St. Marys Falls Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of July, 1884—Cont'd.		
1894. July 3	1 and 2	Pay rolls, June, 1894	1 teamster with team, 2 days, at $3.50 per day.	$7.00
			1 machinist, 5⅔ days, at $3 per day	17.00
July 3	1 and 2	Pay rolls, June, 1894	1 carpenter, 26 days, at $2.50 per day	65.00
			1 scrubber, 18¾ days, at $1.20 per day	22.50
June 30	3	Justin E. Smith	Rent of storeroom at Detroit, Mich., from April 1 to June 30, 1894 (both days inclusive), being 3 months, at $10 per month.	30.00
July 5	4	Board of Public Works, by F. T. McDonald, deputy recorder.	Water rent for second quarter, 1894, from April 1 to June 30 (both dates inclusive), at $9 per year.	2.25
5	5	Edison Sault Electric Co., by Samuel G. Carleton, bookkeeper.	Electric current for 33 arc lamps, from June 1 to June 30, 1894 (both dates inclusive), being 1 month, at $6.50 per month per lamp.	214.50
June 30	6	Telephone and Telegraph Construction Co., Hugh McMillan, treasurer.	Rent of telephone from April 1 to June 30, 1894 (both days inclusive), at $48 per year.	12.00
				55,213.09

Abstract of bids for supplies for operating and care of St. Marys Falls Canal, Michigan, received and opened March 28, 1894, in accordance with advertisement dated March 8, 1894.

No. of bids.	Name and address of bidder.	Supplies.	Total.
1	J. T. Wing & Co., Detroit, Mich	Hardware, ship chandlery, etc	*$2,617.83
2	Robert G. Ferguson, Sault Ste. Marie, Mich	do	3,116.07
3	P. M. Church & Co., Sault Ste. Marie, Mich	do	3,175.35
4	Thompson C. Gill & Co., Philadelphia, Pa	do	†384.80
5	Boston Woven Hose and Rubber Co., Boston, Mass.	do	‡209.00
1	E. D. Johnson, Sault Ste. Marie, Mich	Lumber	*267.06
1	L. D. Kemp, Sault Ste. Marie, Mich	Coal	*471.00
2	Frank Perry, Sault Ste. Marie, Mich	do	480.50
3	Thomas C. Anthony, Sault Ste. Marie, Mich	do	488.00

* Recommended for acceptance.
† Incomplete; bid on steel-wire cable only.
‡ Incomplete; bid on two items of hose only.

M M 3.

IMPROVEMENT OF ST. MARYS RIVER AT THE FALLS, MICHIGAN.

The project for obtaining a navigable channel of 16 feet depth between Lakes Superior and Huron had been barely completed when the demands of commerce so enormously increased that the work of obtaining a depth of 20 feet throughout was undertaken, with the full sanction of both legislative and executive authority.

A necessary part of the project is the construction of a new lock upon the site of the old State locks, to have a length of 800 feet between gates, with a width of 100 feet throughout, a depth of 21 feet on the miter sills, and a single lift approximating 18 feet. The canal is to be deepened to correspond. The estimated cost of this enlargement of the canal system is $4,738,865, for the details of which see p. 2220 *et seq.* of the Annual Report of the Chief of Engineers for 1887.

Prior to June 30, 1890, a total of $1,250,000 had been appropriated for the work. The river and harbor act of September 19, 1890, appropriated an additional $900,000 for continuing the improvement, with the provision "that such contracts as may be desirable may be entered into by the Secretary of War for materials and labor for the entire structure and approaches, or any part of the same, to be paid for as appropriations may from time to time be made by law." The sundry civil act of March 3, 1891, appropriated $600,000 for continuing the improvement during the fiscal year ending June 30, 1892, and the sundry civil act approved March 3, 1893, appropriated $1,230,000 for fiscal year ending June 30, 1894. The total amount appropriated to date, therefore, is $3,980,000, with authority to contract for all or any part of the work. The sundry civil act of March 3, 1893, provided that $25,000, or so much thereof as might be necessary, could be expended in widening the present channel at the Elbow at the lower end of Lake George, St. Marys River. A project for widening the channel to the westward was approved, and the work has been completed.

On June 30, 1893, the condition of the work on St. Marys Falls Canal and its approaches was as follows, viz:

The cofferdam surrounding the site of the 800 foot lock was in good condition; 17,720 cubic yards of concrete, 10,306 cubic yards of cut stone, and 33,576 cubic yards of backing stone had been laid in lock walls and foundations for same.

The north wall was fifteen courses and south wall seventeen courses high between the miter wall of the upper lock gates and the wide part of the walls at the lower end. The wide parts of both walls at lower end were twelve courses high, not counting the extra course at the lower end. Both walls were stepped down to the first course at the miter wall of the upper lock gates. From this miter wall both walls were stepped up so that the wide part of south wall at upper end was eleven courses high, and same part of north wall was ten courses high.

A place was left temporarily for tramways through the length of the lock chamber, but masonry on both sides of the tracks was laid in both the upper lock-gate miter wall and the upper guard gate miter wall. The flat arches were in place over four of the culverts of upper lock-gate miter wall, and the upper guard-gate miter wall was eight courses high at each end, and was stepped down toward axis of lock.

The valves and valve-frames were delivered; the snubbing hooks were delivered and half of them were in position; the anchorages for the gates were nearly all in place.

Canal prism.—Thirty-three thousand seven hundred and thirty cubic yards, bank measure, of Pottsdam sandstone had been removed from first section, according to estimates for payment, and 138,000 cubic yards from second section.

The following contracts were in force during the fiscal year, viz:

Contractor.	For—	Entered into.	Remarks.
Collins & Farwell	Excavating	Mar. 1, 1889	In force.
Hughes Bros. & Bangs	Building masonry	Feb. 9, 1891	Do.
Dunbar & Sullivan	Excavation prism, first section	July 14, 1892	Do.
Do	Excavation prism, second section	do	Do.
Hughes Bros. & Bangs	Constructing floor 800-foot lock	Jan. 30, 1893	Do.
Ferguson Hardware Company	Hardware, ship chandlery, etc	Apr. 27, 1893	Closed Dec., 1893.
E. D. Johnson	Lumber	do	Do.
Hickler Bros	Coal	do	Do.

Contractor.	For—	Entered into.	Remarks.
James Strachan	Machine work	Apr. 27, 1893	Closed Dec., 1893.
Hughes Bros. & Bangs	Turbine power plant 800-foot lock.	May 10, 1893	In force.
R. J. Cram	Dredging at Elbow, Lake George.	June 17, 1893	Closed Dec., 1893.
Willard S. Pope	The gates for 800-foot lock	Sept. 29, 1893	In force.
Southwark Foundry & Machine Co.	The centrifugal pumps	Oct. 20, 1893	Do.
Westinghouse, Church, Kerr & Co.	The driving machinery	do	Do.
The Babcock & Wilcox Co	The Babcock & Wilcox boilers	Oct. 26, 1893	Do.
John M. Lally	Constructing clay dam	Feb. 12, 1894	Do.
Simon Dumond	Excavating within cofferdam and building cribs within cofferdam.	Mar. 23, 1894	Do.
Michigan Brass and Iron Works.	Miter-sill valves 800-foot lock	Mar. 24, 1894	Do.
Robert G. Ferguson	Hardware, ship chandlery, etc	Apr. 14, 1894	Do.
Hickler Bros	Coal	do	Do.

PROGRESS MADE DURING THE FISCAL YEAR ENDING JUNE 30, 1894.

Masonry construction.—Under contract with Messrs. Hughes Bros. & Bangs, dated February 9, 1891, masonry construction was begun June 24, 1891, and was continued during working seasons until November 10, 1893, on which date the masonry was completed, with the exception of laying 128 pieces of coping stone adjacent to the anchor boxes and connecting rods for the lock gates. The anchor boxes, etc., had not been delivered by the United States. On November 11, 1893, articles of agreement supplemental to those of February 9, 1891, were entered into, in which it was provided that the laying of certain cut stones, 128 in number, be deferred until the gate anchorage connections have been placed by the Government, and that the time for the completion of certain earth filling be extended. This supplemental agreement has been extended to October 1, 1894, the anchorage connections not being ready to place in position. With the exception of the 128 stones named above, all the masonry was completed five days before the expiration of the time limit named in the original contract, and a final estimate has been given for all the work done under contract dated February 9, 1891, except for the laying of the deferred stone and for the earth filling.

During the fiscal year the following quantities represent the work done:

	Cubic yards.
Concrete laid during fiscal year:	
For foundations of lock walls	55.25
Walls of pump well	219.75
In dam between locks	815.00
Under inlet and draft pipe	190.00
Total	1,280.00
Total concrete laid prior to July 1, 1893	9,242.00
Total to date	10,522.00
Cut stone laid during fiscal year	8,309.02
Cut stone laid prior to July 1, 1893	10,306.00
Total to date	18,615.02
Backing stone laid during fiscal year	14,700.04
Backing stone laid prior to July 1, 1893	33,576.00
Total to date	48,276.04
Total masonry to date, of which 13,985.55 is mortar and spawls	80,876.61

Of the total masonry 59.7 per cent is backing, 23.1 per cent cut stone, 17.2 per cent mortar and spawls.

Total pieces of cut stone required for lock	14,278
Total pieces of cut stone laid in lock	14,150

Earth filling behind lock walls, 66,920 cubic yards, of which 55,748 cubic yards were placed during the fiscal year.

Of all the backing stone laid the contractors furnished 44,513.25 cubic yards, and the United States 3,762.79 cubic yards, the latter being stone saved from the walls of the old State locks (of 1855).

	Pieces.
Kellys Island stone in "the rough":	
Landed at Sault Ste. Marie to date	15,204

	Barrels.
Cement received and used during fiscal year:	
Portland	2,960
Natural	23,162
Total	26,122
Total cement (Portland and natural) received and used to June 30, 1893	53,835
Total to date	79,957

DEEPENING CANAL PRISM.

This work is divided into two sections and is done under two contracts by the same contractors, Messrs. Dunbar & Sullivan.

First section.—The material to be removed consisted of about 138,700 cubic yards of Potsdam sandstone rock in situ. A depth of 24.68 feet is required, and the contract price is $1.53 per cubic yard, bank measure. The total to June 30, 1894, of the estimates for excavation is 72,076 cubic yards, bank measure, of which 38,346 cubic yards were excavated during the fiscal year.

Second section.—The material to be removed consisted of about 138,800 cubic yards of Potsdam sandstone rock in situ. A depth of 24.68 feet is required, and the contract price is $1.47 per cubic yard, bank measure. The total to June 30, 1894, of the estimates for excavation is 110,951 cubic yards, bank measure, of which 62,177 cubic yards were excavated during the fiscal year.

Four-fifths of the total area comprised in two contracts has been dredged over. The contracts for this work have been extended from June 30, 1894, to July 1, 1895.

DAM BETWEEN LOCKS.

Work of excavating trench for concrete dam between locks was commenced June 5, 1893. The work of building dam commenced August 14 and was practically completed September 13. The work of building a wall of clay by concrete dam was completed November 8, except that portion around inlet pipe.

PIER IN SLIP AT CORNER OF OLD FORT BRADY.

The slip between the Union Dock property and the canal grounds at the corner of old Fort Brady was lengthened. This made it necessary to build about 100 feet of pier, and it was done by day's labor.

CLAY DAM BETWEEN CANAL AND RIVER.

John M. Lally, contractor; contract dated February 12, 1894.

This work consists of digging a trench to bed rock and building in it a wall of puddled clay, about 4 feet thick, to the height of the upper coping of the lock walls; the spaces between the clay wall and the slopes of the trench to be refilled with the material excavated from the trench. The clay wall is to connect with the west end of the north wall of the lock and run westerly about 1,000 feet.

WIDENING CHANNEL AT "ELBOW," LAKE GEORGE.

This channel has been widened for a distance of 2,600 feet; 59,843 cubic yards of earth were removed during the fiscal year and the project completed. R. J. Cram was the contractor.

TURBINE POWER PLANT.

The draft and inlet pipes for this plant were placed in position, tested and accepted. The bell piece, 8 feet long, has not been laid yet. The remainder of this plant can not be installed until the machine house is more advanced. Hughes Bros. & Bangs are the contractors.

LOCK GATES.

The total amount of soft steel, 2,404,657 pounds, required for the construction of the gates has been received at the Detroit Bridge and Iron Works. The work completed and ready for shipment is represented by 380,000 pounds soft steel, 25,700 pounds forged steel, 10,560 pounds of cast steel, and 3,990 pounds of bronze. The work partially completed and under way is represented by 800,000 pounds of soft steel, 90,000 pounds of forged steel, and 25,000 pounds of cast steel. One set of small gates is practically completed and ready for shipment. About one-third of the remainder of the small gates is finished.

A large amount of preparatory work, such as shearing to size the web and sheathing plates, making templates, etc., has been done on the large gates.

The erector is now on the ground preparing for the erection. Willard S. Pope is the contractor.

CONSTRUCTION OF THE FLOOR OF 800-FOOT LOCK.

This work was commenced April 14, 1894, and is progressing satisfactorily. Seven thousand eight hundred and seventy-six cubic yards of broken stone and bed rock were removed from the bottom of the lock pit; 2,020 cubic yards of concrete were laid; 1,260 holes, aggregating 4,541 linear feet, were drilled; 58,718.56 pounds of iron were used, and 226,512 feet B. M. white pine timber. Hughes Bros. & Bangs are the contractors.

EXCAVATION FOR SITE OF THAT PORTION OF NORTH PIER WITHIN COFFERDAM.

The material was excavated to rock for the required length and breadth. Total material excavated, 5,135.17. Hughes Bros. & Bangs were the contractors.

EXCAVATING AND BUILDING CRIBS WITHIN COFFERDAM.

Simon Dumond, contractor; contract dated March 23, 1894.

The work to be done under this contract consists of an excavation for the foundation of the power house, removing all necessary material inside the cofferdam at both ends of the 800-foot lock, and of building three cribs, one crib 150 feet long at the east end of the south wall of the lock; one crib 102 feet long at the east end of the north wall of the lock, and one crib 126 feet long at the west end of the north wall of the lock.

Total earth excavated, 4,777 cubic yards. Total rock excavated, 150 cubic yards. Total timber framed, 2,165 cubic feet.

MITER-SILL VALVES, 800-FOOT LOCK.

This work is under contract. The contract time has been extended to September 1, 1894. The Michigan Brass and Iron Works Company are the contractors.

PRESENT CONDITION OF THE WORK.

Cofferdam.—Clay was rammed into the cofferdam until the 25th of September, 1893, at which time it was permanently discontinued. The dam remains very tight. The lock wall being completed there is no further use for that part of the dam above the locks except about 250 feet at the extreme western end. During the winter season the wickets of the movable dam were sheathed and the dam closed, so that if a leak had occurred the water below the movable dam would have soon lowered to the level of the leak.

Pumping plant.—The pumping plant remains the same as last year, viz, one 10-inch centrifugal pump; one 5-inch contrifugal pump; one 8-inch piston pump. The plant has not been used to more than one-fourth its capacity. On the 10th of December the daily pumping was discontinued, the pit being pumped out about once in twenty days. On the 14th of April daily pumping was resumed.

Lock gates.—The work is under contract and is progressing at about the rate called for in the specifications. The contract time for completion is November 15, 1894.

Valve and gate engines, pumps, and accumulators.—The designs, drawings, and specifications are complete and ready to forward to the Chief of Engineers for approval.

Lock floors, culverts, etc.—This work is under contract and is progressing at about the rate specified. The contract time for completion is December 15, 1894.

Turbine-power plant.—The work is under contract. The contract time for the completion of this work will be one hundred and twenty days after the contractors have been given notice to complete it. This notice can be given at any time after October 15, 1893. The installation of this plant is dependent upon the completion of the machine house up to and including girders for first floor.

Pumping plant for 800-foot lock.—This work is under contract. Its installation is dependent upon the construction of the basement of the machine house. The contract time for its completion is November 15, 1894.

Masonry 800-foot lock.—The masonry is completed, except the laying of 128 stones. The snubbing hooks are in place.

WATER LEVELS.

Daily water-gauge readings above and below the locks were continued during the year, and the annual means for the calendar year 1893 and the monthly means for the various months in the fiscal year have been computed. In order that these published tables may be kept up to date the various monthly and annual means of Lake Superior, St. Marys River just below the locks, and Lake Huron are submitted herewith, and are as follows:

Elevations above sea level.

Month.	Lake Superior.	St. Marys River.	Lake Huron.
	Feet.	*Feet.*	*Feet.*
July, 1893	601.952	583.088	580.84
August, 1893	601.036	582.925	580.70
September, 1893	601.906	582.814	580.41
October, 1893	601.847	582.820	580.20
November, 1893	601.792	582.720	579.97
December, 1893	601.256	582.507	579.77
Annual mean (calendar year)	601.317	582.526	580.09
January, 1894	601.035	582.653	579.72
February, 1894	600.951	582.615	579.73
March, 1894	600.841	582.789	579.88
April, 1894	601.232	582.393	580.11
May, 1894	602.204	582.870	580.51
June, 1894	602.444	583.071	580.81

Difference in elevation.

Month.	Between Lake Superior and Lake Huron.	Between Lake Superior and St. Marys River.	Between St. Marys River and Lake Huron.
	Feet.	*Feet.*	*Feet.*
July, 1893	21.11	18.86	2.25
August, 1893	21.33	19.11	2.23
September, 1893	21.50	19.09	2.40
October, 1893	21.65	19.03	2.62
November, 1893	21.82	19.07	2.75
December, 1893	21.49	18.75	2.74
Annual mean (calendar year)	21.25	18.79	2.44
January, 1894	21.31	18.38	2.93
February, 1894	21.22	18.34	2.88
March, 1894	20.96	18.05	2.91
April, 1894	21.12	18.84	2.28
May, 1894	21.69	19.33	2.36
June, 1894	21.63	19.37	2.26

Diagrams showing water-level curves for lakes Superior and Huron from January, 1890, to date are transmitted herewith.

Cement tests.—A series of cement tests and experiments of professional interest have been carried on under the direction of Mr. E. S. Wheeler, assistant engineer, by Mr. L. C. Sabin, assistant engineer. A description of these tests and experiments, together with a detailed description of the operations during the last fiscal year, will be found in Mr. E. S. Wheeler's report, appended hereto.

The work is under the local charge of Mr. E. S. Wheeler, assistant engineer. He has been assisted at various times during the year by Assistant Engineers Joseph Ripley, J. L. Callard, Frank Reed, L. C. Sabin, B. Rohnert, F. C. Shenehon, and C. Y. Dixon; Clerk R. Common, Draftsman A. Mangelsdorf, and Inspector L. P. Morrison.

Assistant Engineer David Molitor is inspector for the lock gates. Mr. F. M. Dunlap has been employed in this office during the fiscal year designing and preparing drawings and specifications for the operating machinery.

The estimated cost of the enlargement of the canal system is $4,738,865, of which $3,980,000 has been appropriated, $25,000 of which may be expended in widening the channel at the "elbow" in Lake

George, St. Marys River. This latter work is not included in my estimate printed in the Annual Report of the Chief of Engineers for 1887, p. 2280 *et seq.* The amount yet to be provided by appropriation, therefore, is $783,365, of which amount $500,000 will be required during the fiscal year ending June 30, 1896:

Total expenditure to June 30, 1893	$1,442,567.80
Expended during fiscal year (exclusive of outstanding liabilities)	819,414.87
Total expenditures to June 30, 1894	2,261,982.57

The work is in the collection district of Superior, Michigan. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. The nearest light-houses are the beacons on the western end of the canal, and Fort Brady is within a mile.

Money statement.

July 1, 1893, balance unexpened		$2,537,458.83
June 30, 1894, amount expended during fiscal year		819,414.87
July 1, 1894, balance unexpended		1,718,043.96
July 1, 1894, outstanding liabilities	$85,562.60	
July 1, 1894, amount covered by uncompleted contracts	769,474.06	
		855,036.66
July 1, 1894, balance available		863,007.30
Amount (estimated) required for completion of existing project		783,865.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		500,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Appropriations for improving St. Marys River, Michigan.

August 5, 1886	$250,000
August 11, 1888	1,000,000
September 19, 1890	900,000
March 3, 1891, sundry civil bill	600,000
March 3, 1893, sundry civil bill	1,230,000
Total	3,980,000

Abstract of bids for the gates for the 800-foot lock, St. Marys Falls Canal, Michigan, received and opened September 19, 1893, in accordance with advertisement dated July 21, 1893.

No.	Name and address of bidder.	Soft steel, 2,404,657 pounds (price per pound).	Forged and high steel, 119,168 pounds (price per pound).	Cast steel, 36,167 pounds (price per pound).	Cast iron, 8,665 pounds (price per pound).	Phosphor or aluminum bronze, 5,322 pounds (price per pound).	Oak plank and cushions, 7,215 feet, B. M. (price per M feet, B. M.).	Pumps and fittings, as specified (price, total).	Total.
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*			
1	Willard S. Pope, Detroit, Mich	5.9	27.25	9.25	6	35	$60.00	$2,100.00	*$182,608.99
2	Chicago Ship Building Co., South Chicago, Ill.	7.28	13	11	6.4	37.5	100.00	1,470.00	199,271.05
3	Riter & Conley, Pittsburg, Pa	6.75	37	10.7	9.4	62.6	87.50	3,446.10	218,499.87
4	King Bridge Co., Cleveland, Ohio	7	42	8	4.5	30	50.00	1,000.00	224,617.18
5	John P. McGuire, Cleveland, Ohio	7.9	37.67	9.6	8	45	70.00	2,100.00	244,023.60
6	Detroit Dry Dock Co., Detroit, Mich	9.3	48.5	13	9.3	51.75	75.00	1,500.00	†291,732.38

* Recommended for acceptance.

† Guaranty, justification, and certificate not executed.

Abstract of bids for pumping plant of the 800-foot lock, St. Marys Falls Canal, Michigan, received and opened September 27, 1893, in accordance with advertisement dated July 29, 1893.

No.	Name and address of bidder.	(A) For the centrifugal pumps.	(B) For the driving machinery.	(C) For the Babcock & Wilcox boilers.
1	Southwark Foundry and Machine Co., Philadelphia, Pa.*	$21,935		
2	Mackintosh, Hemphill & Co., Pittsburg, Pa	35,000		
3	Morgan Engineering Co., Alliance, Ohio	46,772		
1	Westinghouse, Church, Kerr & Co., New York, N. Y.*		$16,375	
2	Manning, Maxwell & Moore, New York, N. Y		16,912	
3	Morgan Engineering Co., Alliance, Ohio†		17,485	
1	The Babcock & Wilcox Co., New York, N. Y.*			$47,574
2	Manning, Maxwell & Moore, New York, N. Y			48,935

* Recommended for acceptance.
† No separate bid made; included in bid No. 3, item A.

Abstract of bids for constructing a clay dam at the west end of the 800-foot lock, St. Marys Falls Canal, Michigan, received and opened February 5, 1894, in accordance with advertisement dated January 16, 1894.

No.	Name and address of bidder.	Excavating and disposing of material, 7,500 cubic yards, more or less (per cubic yard).	Furnishing and building into wall clay, 4,200 cubic yards, more or less (per cubic yard).	Refilling or building into embankment material, 550 cubic yards, more or less (per cubic yard).	Approximate total.
1	John M. Lally, Detroit, Mich	$0.65	$0.85	$0.15	*$8,527.50
2	B. McEvoy and L. J. Cody, Sault Ste. Marie, Mich	1.30	1.20	.45	15,037.00
3	Hughes Bros. & Bangs, Syracuse, N. Y	1.50	1.50	.50	17,825.00
4	James L. Lipsett and Robert Gregg, Sault Ste. Marie, Mich	1.25	2.00	.50	18,050.00
5	Sadler & Allen, Detroit, Mich	1.41½	1.75	.30	18,115.00
6	Martin Lynch, Sault Ste. Marie, Mich	1.50	1.75	.45	18,847.50
7	Simon Dumond, Sault Ste. Marie, Mich	2.40	.75	.49	21,419.50
8	A. Mitchell, Sault Ste. Marie, Mich	2.50	1.20	.50	24,065.00
9	James Strachan, Sault Ste. Marie, Mich	3.47	1.24	.50	31,508.00

* Recommended for acceptance.

Abstract of bids for supplies for improving Saint Marys River, Michigan, received and opened March 28, 1894, in accordance with advertisement dated March 8, 1894.

No.	Name and address of bidder.	Supplies.	Total.
1	Robert G. Ferguson, Sault Ste. Marie, Mich	Hardware, ship chandlery, etc	*$1,548.11
2	P. M. Church & Co., Sault Ste. Marie, Mich	do	1,620.13
3	Boston Woven Hose and Rubber Co., Boston, Mass	do	†438.25
1	Hickler Bros., Sault Ste. Marie, Mich	Coal	*868.50
2	Frank Perry, Sault Ste. Marie, Mich	do	871.25
3	L. D. Kemp, Sault Ste. Marie, Mich	do	881.25
4	Thomas C. Anthony, Sault Ste. Marie, Mich	do	892.00

* Recommended for acceptance.
† Incomplete, bid on five items of hose and packing only.

Abstract of bids for (A) *excavation within cofferdam;* (B) *building cribs within cofferdam;* (C) *miter-sill valves for the 800-foot lock, St. Marys Falls Canal, Michigan; received and opened on March 12, 1894, in accordance with advertisement dated February 9, 1894.*

A.—EXCAVATION WITHIN COFFERDAM.

No.	Name and address of bidder.	Earth excavation, 29,950 cubic yards more or less (per cubic yard).	Rock excavation, 4,540 cubic yards more or less (per cubic yard).	Total.
1	Simon Dumond, Sault de Sainte Marie, Mich	$0.45	$1.25	* $19,152.50
2	Sadler & Allen, Detroit, Mich	.45	1.30	19,379.50
3	Daniel W. Powell and Edward and John Mitchell, Marquette, Mich	.62	.90	22,836.60
4	Hughes Bros. & Bangs, Syracuse, N. Y	.74	1.12	27,247.80
5	A. Mitchell, Sault de Sainte Marie, Mich	.82	1.23	30,143.20
6	James L. Lipsett and Robert Gregg, Sault Ste. Marie, Mich	.83½	1.85½	33,339.15

* Recommended for acceptance.

B.—BUILDING CRIBS WITHIN COFFERDAM.

No.	Name and address of bidder.	Framing, etc., 40,000 cubic feet, more or less (per cubic foot).	Filling 5,500 cubic yards, more or less (per cubic yard).	Total.
		Cents.	*Cents.*	
1	Simon Dumond, Sault de Sainte Marie, Mich	6½	40	* $4,800.00
2	Martin Lynch, Sault de Sainte Marie, Mich	5½	60	5,500.00
3	Sadler & Allen, Detroit, Mich	7	53	5,715.00
4	Daniel W. Powell and Edward and John Mitchell, Marquette, Mich	8½	50	† 6,150.00
5	A. Mitchell, Sault de Sainte Marie, Mich	8	55	6,225.00
6	James L. Lipsett and Robert Gregg, Sault Ste. Marie, Mich	11½	43½	6,992.50
7	Hughes Bros. & Bangs, Syracuse, N. Y	9	70	7,450.00
8	C. E. Mitchell & Co., Ludington, Mich	9	80	8,000.00

* Recommended for acceptance; bid made on same blank with Item A.
† Bid made on same blank with Item A.

C.—MITER-SILL VALVES.

No.	Name and address of bidder.	Amount.
1	Michigan Brass and Iron Works, Detroit, Mich	* $2,390
2	Andrew Harvey, Detroit, Mich	2,442
3	Frontier Iron Works, Detroit, Mich	2,750
4	James Flower, Bro. & Co., Detroit, Mich	2,950
5	Robert C. Bialy, Bay City, Mich	2,995
6	Manhard-Jopling & Company, Limited, Marquette, Mich	3,450
7	Hughes Bros. & Bangs, Syracuse, N. Y	3,500
8	Murdock Valve Company, Detroit, Mich	3,850

* Recommended for acceptance.

REPORT OF MR. E. S. WHEELER, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Sault de Sainte Marie, Mich., July 3, 1894.

COLONEL: I have the honor to make the following report of operations connected with the improving St. Marys River, Michigan, during the fiscal year ending June 30, 1894:

There have been no accidents of magnitude, or any unusual events connected with the prosecution of the work during the fiscal year.

There have been no leaks in the cofferdam.

The lock masonry has been completed. The canal above the lock has been so far completed that there is no longer any grounding of boats in this part of the canal.

The lock floor is well under way and will, no doubt, be completed this season.

The following contracts have been in force during the year. The list has been prepared by Clerk R. Common:

Contractor.	For—	Entered into—	Remarks.
Collins & Farwell	Excavating lock pit	Mar. 1, 1889	In force.
Hughes Bros. & Bangs	Building masonry	Feb. 9, 1891	Closed December, 1893.
Do	Excavating material	Oct. 28, 1891	Closed May, 1894.
Dunbar & Sullivan	Excavating material section 1, canal.	July 14, 1892	In force.
Do	Excavating material section 1, canal.	....do	Do.
Hughes Bros. & Bangs	Constructing lock floor	Jan. 30, 1893	Do.
Ferguson Hardware Company	Hardware and ship chandlery	Apr. 27, 1893	Closed July, 1893.
Hickler Brothers	Furnishing coal	....do	Closed November, 1893.
E. D. Johnson	Lumber and shingles	....do	Closed December, 1893.
James Strachan	Machine work	....do	Closed November, 1893.
Hughes Bros. & Bangs	Turbine power plant	May 10, 1893	In force.
R. J. Cram	Excavating "elbow," St. Marys River.	June 17, 1893	Closed December, 1893.
Hughes Bros. & Bangs	Excavating west end north wall.	Aug. 25, 1893	Closed June, 1894.
Willard S. Pope	Gates, etc	Sept. 29, 1893	In force.
Southwark Foundry and Machine Company.	Centrifugal pumps	Oct. 20, 1893	Do.
Westinghouse, Church, Kerr & Co.	Driving machinery	....do	Do.
Babcock & Wilcox Co.	Babcock & Wilcox boilers	Oct. 26, 1893	Do.
Hughes Bros. & Bangs	Building masonry	Nov. 11, 1893	Do.
John M. Lally	Clay dam	Feb. 12, 1894	Do.
Simon Dumond	Excavating and building cribs.	Mar. 23, 1894	Do.
Michigan Brass and Iron Works.	Gate valves	....do	Do.
Hickler Brothers	Furnishing coal	Apr. 14, 1894	Do.
Robert G. Ferguson	Hardware, ship chandlery, etc.	....do	Do.

Fifteen contracts in force June 30, 1894.

PUMPING PLANT.

The pumping plant remains the same as last year, viz: One 10-inch centrifugal pump; one 5-inch centrifugal pump; one 8-inch piston pump. This plant has not been used to more than one-fourth its capacity. On the 10th of December, the daily pumping was discontinued, the pit being pumped out about once in twenty days. On the 14th of April daily pumping was resumed.

COFFERDAM.

Clay was rammed into the cofferdam until the 25th of September, at which time it was permanently discontinued. The dam remains very tight. The lock wall being completed, there is no further use for that part of the dam above the locks except about 250 feet at the extreme western end.

During the winter season the wickets of the movable dam were sheathed and the dam closed, so that if a leak had occurred the water below the movable dam would have soon lowered to the level of the leak.

PIER IN SLIP AT CORNER OF OLD FORT BRADY.

The slip between the Union Dock property and the canal grounds at the corner of old Fort Brady was lengthened. This made it necessary to build about 100 feet of pier; this was done by day labor.

A clay dam has been begun between the canal and the river. The purpose of this dam is to prevent the water from breaking through from the canal into the rapids. About 100 linear feet have been completed by day labor. The earth is first removed down to the solid rock, the trench is then filled with well-rammed clay. This small amount was done by day labor for the purpose of determining the character of the work. The remainder has been let by contract, and is now under construction.

LAKE GEORGE WORK.

Some work has been done in Lake George, widening the channel at the "Elbow." This contract was obtained by R. J. Cram. The channel was increased in width for a distance of 2,600 feet. There were 59,843 yards of earth removed.

WATER LEVELS.

The water level observations have been made daily during the year. The monthly means and differences are as follows:

1893.	Feet above sea level.
July:	
Above locks	601.952
Below locks	583.088
Difference	18.864
August:	
Above locks	602.036
Below locks	582.925
Difference	19.111
September:	
Above locks	601.906
Below locks	582.814
Difference	19.092
October:	
Above locks	601.847
Below locks	582.820
Difference	19.027
November:	
Above locks	601.792
Below locks	582.720
Difference	19.072
December:	
Above locks	601.256
Below locks	582.507
Difference	18.749
1894.	
January:	
Above locks	601.035
Below locks	582.653
Difference	18.382
February:	
Above locks	600.951
Below locks	582.615
Difference	18.336
March:	
Above locks	600.841
Below locks	582.789
Difference	18.052
April:	
Above locks	601.228
Below locks	582.391
Difference	18.837
May:	
Above locks	602.209
Below locks	582.870
Difference	19.334

1894—Continued.

June:	Feet above sea level.
Above locks	602.444
Below locks	583.071
Difference	19.373

The general outline of work on lock for the year is as follows:

This item has been prepared under the direction of Clerk R. Common by Inspector Fleming.

The work during the season of 1893 was done under same system as in 1892.

Operations at stone yard.—In dressing stone for face and special parts of masonry of 800-foot lock, Contractors Hughes Bros. & Bangs had in operation the same plant as in 1892, which was repaired and fitted up and made ready for the season's work early in February. The work of getting zinc patterns in shape was commenced March 20, and on March 27 a force of laborers began the work of clearing snow from the track of traveling-crane, which was from 2 to 6 feet deep. On March 30 the crane and the 4 planers were started with a full force operating both day and night, working eleven hours during the day and eleven and a half at night. The work of planing stone continued until November 11, when it was completed. Considerable delay during the season was occasioned by breakages; in some instances duplicate parts were required from the manufacturers in Vermont. The force employed in operating this plant was the same as in 1892. The planer chips were deposited at east end of yard, and some of this material was used by the Government making walks and as top dressing for piers. After the work of planing stone for the lock was completed the plant was left intact, the planer shed being suitably inclosed to protect machinery from the weather.

The work of cutting stone was commenced April 10 with a force of 70 cutters and the usual complement of attendants. This force was increased and reached a maximum of 146 cutters, September 11. The force was reduced to 85 cutters on November 13 and gradually reduced from this date until November 20 when the total number of cut stone required for the masonry of the 800-foot lock was completed.

The work of cutting channels in stone to admit snubbing hooks was completed in May.

After work was completed the power used in operating the steam derrick at east end of the yard was shipped to the Point Judith improvement, Rhode Island; the remainder of plant was left intact, together with the uncut stone remaining in the yard.

The season's work was done without accident resulting in serious injury to any of workmen.

The stonecutters worked ten hours per day up to October 11; nine and three-fourths hours from October 11 to 23, nine and one-half hours from October 23 to November 9, and nine and one-quarter hours from November 9 to close of season.

The aggregate delay during the season caused by inclement weather was fifteen days.

There were received during the season forty-three cargoes aggregating 5,724 pieces Kelley Island stone in the rough, the first vessel arriving on the 3d of May and the last one on the 28th of October.

Finished stone were transferred from stone yard to lock pit from May 1 to November 16; the work of towing stone scows being principally done by harbor tugs.

Below is given a table showing average daily force employed at stone yard for each month, with tables and averages for the entire season of 1893:

1893.	Foremen.	Stonecutters.	Planer runners.	All other laborers.	Total force.
January				2	2
March	1			5	6
April	1	72	8	30	111
May	1	89	7	53	150
June	1	89	7	45	142
July	1	88	8	44	141
August	1	115	8	46	170
September	1	129	8	44	182
October	1	112	8	43	164
November	1	78	8	20	107
Total, season	9	772	62	332	....
Average, season	*1	†97	†8	‡33	....

*9 months. †8 months. ‡10 months.

Operations at lock pit.—During the season of 1893 work at lock pit was done unper four contracts. That of laying masonry and filling back of walls, excavating to obtain foundation for permanent pier, laying inlet and draft pipes of turbine power plant, and receiving and storing timber for lock floors.

In laying masonry, contractors Hughes Bros. & Bangs had, in addition to their plant used in 1892, several guy derricks to assist in laying stone and for handling material from excavation. Tracks were also laid to haul cars of material over for filling, etc.

Two cranes at west end of pit were placed on elevated trestles to enable them to place stone in wide walls. The booms of two cranes at east end were lengthened to accomplish the same purpose.

The plant was repaired and fitted up and active operations commenced on April 25, clearing off walls and removing refuse stone and spalls from the culvert.

The work of laying face stone in masonry was commenced on April 29 with two gangs, and that of laying backing stone on May 5 with three gangs, increased to five on the 6th and to six on the 8th. This work was continued with full force until October 27, when one gang was laid off; two more gangs were laid off on November 1, and another on November 9. On November 10 the work of laying masonry was completed except the laying of coping stone over anchor boxes and connecting rods. These stones were placed on the walls near the places they are to occupy and suitably covered to protect from frost.

All the stones belonging to the Government that were suitable were used in backing of masonry, those from pile near movable dam being brought down to the works on scows.

The small rock-crusher mentioned in my report for 1892 was operated at intervals during the season, crushing rock for concrete which was used in building foundations for miter walls, building walls of pumping well, building concrete dam between masonry of the two locks, filling between masonry and rock face of lock pit, building supports to inlet and draft pipes, etc.

Work of excavating trench for concrete dam between locks was commenced June 5. The work of building dam commenced August 14 and was practically completed September 13. The work of building a wall of clay by concrete dam was completed November 8, except that portion around inlet pipe.

The work of filling back of walls commenced with a large force on June 21 and continued throughout the balance of the season. Additional stable room was provided for teams engaged in this work.

Tug *Arthur* commenced her season's work May 1 and closed on December 9.

Sand was procured from same pumping ground and in same manner as in 1892. The first load was brought on May 19 and the last one on November 23. Below is given a table of sand received, by months, during the season:

1893.	Cargoes.	Cubic yards.
May	6	530
June	14	1,260
July	9	810
August	6	540
September	8	720
October	4	360
November	5	450
Total	52	4,670

The first consignment of natural cement was received on May 6 and the last on October 3. Below is given a table showing quantities received, by months, during the season:

1893.	Consignments.	Barrels.
May	4	7,055
June	2	2,943
July	5	6,677
August	2	6,017
September	4	4,609
October	1	150
Total	18	27,451

The first consignment of Portland cement was received on July 6 and the last on October 29. Below is given a table showing quantities received, by months, during the season:

1893.	Consignments.	Barrels.
July	2	996
August	1	1,057
September	1	675
October	1	299
Total	5	3,027

The backing stone was brought from Drummond Island by subcontractors, Leatham & Smith, with a fleet of 1 tug and 5 barges and scows, occasionally assisted by river tugs. This fleet was only able to keep force of masons in backing stone, and a strike at quarry in June delayed the work of laying masonry a short time. The first cargo was brought May 4 and the last one October 23. Below is given table showing approximate quantities received, by months, during the season of 1893:

1893.	Cargoes.	Cubic yards.
May	15	3,468
June	21	4,521
July	20	4,108
August	22	4,467
September	18	3,749
October	8	1,240
Total	104	21,553

Drummond Island quarry was opened April 15 with a force of 260 men, principally Italians.

The quarry was practically closed on October 9, and October 23 the plant had all been brought up to the "Sault" on stone barges.

The work of excavating for northwest pier commenced August 29 and continued with small force throughout the remainder of season.

The inlet and draft pipes of turbine-power plant were received in several different lots between August 11 and October 28. The work of laying pipe in position and calking joints was commenced August 28. A small portable gin with hand winch was provided to assist in laying the pipes. After two unsuccessful attempts, owing to failure of temporary caps at ends, the draft pipe was tested to the required pressure on November 20. In testing the inlet pipe on November 23 the large valve was broken before the required pressure was reached. Owing to the lateness of the season it was impossible to provide another valve this season. The broken valve was shipped to manufacturers.

Two cargoes, aggregating 578,766 feet, of timber for lock floors were received and stored in July and August.

After close of season's work, 5 traveling cranes were taken from the lock pit and shipped away, together with other parts of plant. About 200 feet of west ends of trestles were removed, and the work of cleaning refuse stone from lock pit was done up to November 22. The work of laying up plant was completed December 16.

On June 30, 1893, one of the workmen on north wall accidentally stepped backward off the wall, falling a distance of about 25 feet to projecting foundation below, fracturing his skull. He died of these injuries July 4. This has been the only fatality to any of Hughes Bros. & Bangs' employés at this point during the progress of the work thus far.

The force in lock pit worked nine hours per day during January and February, ten hours per day from March 1 to October 9, and nine and one-half hours per day for the remainder of season.

The aggregate delay occasioned by inclement weather during the season was seventeen days.

Below is given a table showing average daily force at lock pit for each month and average monthly force for the season of 1893:

1893.	Masons.	All other laborers.	Double teams.	Single teams.	Total laborers.
January	....	12	1	....	12
February	....	18	1	....	18
March	....	10	1	....	10
April	....	21	0	1	21
May	23	125	2	6	148
June	31	149	4	8	180
July	26	173	7	8	199
August	29	186	8	10	215
September	24	226	12	12	250
October	16	210	15	10	226
November	15	147	11	5	162
December	....	22	3	....	22
Total	164	1,299	65	60	....
Average for season	*23	†108	†5	‡8	....

* Seven months. † Twelve months. ‡ Eight months.

The total force at this point, including stone yard and lock pit, exclusive of teams, was as follows:

1893.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Stone yard	2	......	6	111	150	142	141	170	182	164	107	......
Lock pit	12	18	10	21	148	180	199	215	250	226	162	22
Total	14	18	16	132	298	322	340	385	432	390	269	22

The following report upon lock work has been prepared by Assistant Engineer J. L. Callard, who has had special charge of this part of the work:

MASONRY CONSTRUCTION.

Hughes Bros. & Bangs, contractors; contract dated February 9, 1891.

Records, etc.—All records, computations, and field books pertaining to the construction of the 800-foot lock have been checked to the close of the season of 1893. This work was done during the winter.

Zinc patterns.—There have been 471 zinc patterns cut, of which 38 were cut during the fiscal year.

Lock walls.—The walls of the 800-foot lock were completed November 10, 1893, with the exception of laying 128 pieces of coping stones adjacent to the anchor boxes. The United States had not delivered the anchor boxes for the lock gates, and it was necessary that these should be put in place and the anchor rods attached to them before the coping stones adjacent to them could be laid. At the instance of the United States the contract was considered completed, and a supplemental contract for the completion of the work was entered into between the United States and Hughes Bros. & Bangs.

Cut stone.—Total cut stone laid, 18,615.02 cubic yards, of which 8,309.02 cubic yards were laid during the fiscal year. Total number of pieces of cut stone laid, 14,150, of which 6,579 pieces were laid during the fiscal year. Total number of barrels of cement used for laying cut stone, 4,525; an average of 0.244 barrel per cubic yard of cut stone, or 0.231 barrel per cubic yard of cut-stone masonry laid.

Backing stone.—Total backing stone laid, 48,276.04 cubic yards, of which 14,700.04 cubic yards were laid during the fiscal year. Hughes Bros. & Bangs furnished 44,513.25 cubic yards of backing stone and the United States 3,762.79 cubic yards. Total number of barrels of cement used for laying the backing stone, 58,410; an average of 1.21 barrels per cubic yard of backing stone laid.

Masonry.—Total masonry laid, 80,876.61 cubic yards, of which 27,651.61 cubic yards were laid during the fiscal year. Of the total masonry laid, 48,276.04, cubic yards, or 59.7 per cent, is backing stone; 18,615.02 cubic yards, or 23.1 per cent, is cut stone; and 13,985.55 cubic yards, or 17.2 per cent, is mortar. Total number of barrels of cement used for laying masonry, 62,935; an average of 0.778 barrel per cubic yard of masonry.

Concrete.—Total concrete laid, 10,522 cubic yards, of which 1,280 cubic yards were laid during the fiscal year. Of the amount laid, 8,475.25 cubic yards were for foundations of lock walls; 558 cubic yards were placed in the spaces between the back of the lock walls and the rock face of the excavation; 483.75 cubic yards in the walls of the pump well; 815 cubic yards in the bulkhead between the two locks, and 190 cubic yards under the inlet and draft pipes. Total number of barrels of cement used for concrete, 16,221; an average of 1.542 barrels per cubic yard of concrete.

Earth filling.—Total earth filling placed behind the lock walls, 66,920 cubic yards, of which 55,748 cubic yards were placed during the fiscal year.

INLET AND DRAFT PIPES.

Hughes Bros. & Bangs, contractors; contract dated May 10, 1893.

The inlet and draft pipes are cast iron, 4 feet in diameter and 1¼ inches thick, and except the curved pieces are in sections 12 feet long. They were manufactured by the Addyston Pipe and Steel Company, Cincinnati, Ohio, and were required to stand a test of 100 pounds per square inch, hydraulic pressure. The draft pipe was successfully tested November 20, 1893, but on attempting to test the inlet pipe, November 23, the valve at the intake end of the pipe failed under a pressure of 85 pounds per square inch; the valve was manufactured by the Rensselaer Company, Troy, N. Y. A heavier valve was furnished and another attempt was made to test the pipe on May 23, 1894, when a crack was discovered in one of the straight sections. A band of steel one-half inch thick and 4 feet wide was placed around the pipe, leaving a space of one-half inch between the pipe and the band. The band was in two semicircular sections fastened together with flanged joints. The space between the pipe and lower section of the band was carefully packed with wire insertion asbestus to within about 6 inches of the edges; these spaces were filled with lead; the whole space between the pipe and the upper section of the band was filled with lead. The lead around the edges of the band was carefully calked. The pipe was successfully tested May 28. The total length of the pipes is 1,163.21 linear feet; this includes a bell piece 8 feet long to be placed at the west end of the inlet pipe which has not yet been laid.

CONSTRUCTION OF FLOOR OF 800-FOOT LOCK.

Hughes Bros. & Bangs, contractors; contract dated June 30, 1893.

The general plan of the lock and culvert floors are as follows: Longitudinal timbers, 12 inches square, are placed about 10 feet apart; on these transverse timbers, 12 inches square, are placed 6 inches apart, and on these are laid two longitudinal courses of 3-inch plank. The sides of the culverts are 2 feet thick and 8 feet high, and are made by bolting timbers, 12 inches square, one on top of the other. The timber for the floors is white pine, that for the miter sills and valve frames white oak. The longitudinal and transverse timbers are bolted to the rock with fox-wedged bolts 1¼ inches in diameter. Each fox-wedged bolt is threaded at its upper end and provided with a nut and washer, and enters the rock sufficiently to resist an upward pull of 10 tons. The pull is applied to the bolt by means of 2 Dudgeon hydraulic jacks; the intensity of the pull is registered by a Duckham weighing machine. All the space between the foundations and the lock floor, exclusive of that actually occupied by the timber and that in the interior of the culverts, is filled with concrete.

Work was begun on the lock floor April 14, 1894.

Material excavated.—There have been removed from the bottom of the lock pit 7,876 cubic yards of broken stone and bed rock.

Concrete.—The concrete for the lock floor is composed of one part natural cement, one and three-fourths parts sand, and four parts broken stone. Total concrete laid to date, 2,020 cubic yards.

Drilling.—To date the drilling has been done by hand with the ordinary churn drill. Total linear feet drilled, 4,541. Total number of holes drilled, 1,260; an average of 3,604 linear feet per hole.

Iron.—The iron consists of fox-wedged bolts, 1¼ inches in diameter, of varying lengths, weighing 5.828 pounds per linear foot, nuts weighing 3.10 pounds each; wrought iron washers, weighing 7 pounds each; wedges, weighing 1.08 pounds each; driftbolts, 1 inch in diameter, 34 inches long, weighing 7.47 pounds each; driftbolts, 1 inch in diameter, 22 inches long, weighing 4.77 pounds each; spikes, 10 inches long, 7/16 inches square, weighing 0.55 pound each; spikes, 8 inches long, 7/16 inches square, weighing 0.45 pound each. Total iron used, 58,718.56 pounds, of which 3,493.07 pounds are fox-wedged bolts, 3,906 pounds are nuts, 8,820 pounds are washers, 1,360.8 pounds are wedges, 5,189.76 pounds are 22-inch driftbolts 4 507.65 pounds are 8-inch spikes.

Timber.—Total timber placed, 226,512 feet, B. M., white pine.

Plant.—The stone for the concrete is crushed by two Gate's stone crushers, a No. 3 and a No. 1· the No. 3 is operated with a 50-kilowatt motor and the No. 1 is operated with a 15-kilowatt motor. The bolts are threaded with a Jarecki pipe machine, No. 7, and the slots are cut in the ends of the bolts to receive the wedge with a hot metal saw, manufactured by Peter Gerlach & Co., Cleveland, Ohio; a 15-kilowatt motor operates both of these machines. A cutting-off saw is used for sawing off the ends of the timbers and a boring machine is used for boring the holes for the bolts in the same. The saw is 36 inches in diameter, automatic feeding, and is operated with a 15-kilowatt motor. The auger is a portable machine, having a vertical and a horizontal motion of 12 inches, and is operated by a 3-kilowatt motor. Both machines are manufactured by J. A. Fay & Co., Cincinnati, Ohio. The remainder of the plant used for the construction of the lock floor is a part of that used for the masonry construction.

EXCAVATION FOR SITE FOR NORTHWEST PIER.

Hughes Bros. & Bangs, contractors; contract dated August 25, 1893.

The material has been excavated to rock for the required length and width; total material excavated, 5,135.17 cubic yards.

CONSTRUCTION OF CLAY DAM.

John M. Lally, contractor; contract dated February 12, 1894.

This work consists of digging a trench to bed rock and building in it a wall of puddled clay about 4 feet thick to the height of the upper coping of the lock walls, the spaces between the clay wall and the slopes of the trench to be refilled with the material excavated from the trench. The clay wall is to connect with the west end of the north wall of the lock and run westwardly about 1,000 feet.

Plant.—The plant consists of a small stiff-legged derrick operated with a steam hoisting engine, cylinder 4¼ by 6 inches (the derrick and engine are both manufactured by the American Hoist and Derrick Company, St. Paul, Minn.); a 4-inch centrifugal pump, manufactured by Irvin Van Wie, Syracuse, N. Y., operated with a 6-kilo Watt motor, and two No. 2 Londs patent hand pumps, manufactured by B. & L. Block Company, Boston, Mass.

Work on the contract was not fairly begun until June 13, owing to delay in receiving centrifugal pump.

Total material excavated from trench, 700 cubic yards.

Total clay placed in wall, 111 cubic yards.

EXCAVATING AND BUILDING CRIBS WITHIN COFFERDAMS.

Simon Dumond, contractor; contract dated March 23, 1894.

The work to be done under this contract consists of an excavation for the foundation of the power house, removing all necessary material inside the cofferdam at both ends of the 800-foot lock, and of building 3 cribs—1 crib 150 feet long at the east end of the south wall of the lock, 1 crib 102 feet long at the east end of the north wall of the lock, and 1 crib 126 feet long at the west end of the north wall of the lock.

Plant.—The plant consists mainly of 2 derricks operated with 2 Lidgerwood double-cylinder double-drum hoisting engines, 8 dump boxes, and 8 tram cars.

Total earth excavated, 4,777 cubic yards. Total rock excavated, 150 cubic yards. Total timber framed 2,165 cubic feet.

The following item has been prepared by Assistant Engineer F. H. Reed, who has had special charge of this portion of the work.

CUT STONE.

The stonecutting being now completed, it is the purpose of this item to give a historical sketch of the progress of this portion of the work since its beginning in 1891. Although this to a certain extent involves a repetition of some portions, yet the advantage is gained of having the whole subject embodied in a single report.

The cutting was all done by Hughes Bros. & Bangs, under contract dated February 9, 1891, the contractors furnishing, cutting, and delivering the stone for $26 per cubic yard. Monthly estimates were made of the actual amount accepted, less the estimated amount of loss or damage, if any, sustained by work previously accepted, the inspection not being considered final until the completion of the contract. Of these estimates 75 per cent was paid after being delivered and accepted (before it was laid); the remaining 25 per cent was not paid until after being delivered and accepted in the wall.

All coping was Bushhammered, with a 2-inch chisel-draft (with fine tooling). The stones for the anchorage system, having no show faces, were simply pointed.

All surfaces showing in the interior of the cable passages were Bushhammered, with a one-fourth inch chamfer at the edges, except at each end of the passages, where the finish was in harmony with the adjacent work.

The face stones for the miter walls and the first eleven courses (those being below the surface of water in lower pool) of the main walls were all cut with a one-fourth-inch chamfer and a 2-inch tooled chisel-draft. The tooling showed 3 tool-marks to the inch. The space inclosed by the chisel-draft was rock face, with no depression below the plane of the face and no protection greater than 1 inch above it.

The show faces of the remaining courses, including those at the east end of lock around the stairways leading to the upper level, were finished in a similar manner, except that a Bushhammered surface, lying in the same plane as the tooled margin, was substituted for the rock face.

The stones for the miter walls were cut to three-eighth-inch joints throughout; the coping the same, except for bed-joints overlying backing, where joints not exceeding 1 inch were permitted.

The stones for the face of the main walls and cable passages were cut to three-eighth-inch horizontal joints, except where overlying backing, where 1-inch joints were permitted.

The vertical joints of these stones were three-eighths of an inch for 18 inches from the face, joints not exceeding 1 inch being permitted back of that distance.

A variation not exceeding one-sixteenth of an inch in the dimensions along the face of each stone was permitted in the inspection of the cutting, excepting the quoins, which were cut as closely to the pattern as possible.

The stones for the coping (twenty-third course) and first course were cut 18 inches in thickness, less the joint. Those for the remaining courses, excepting a few special parts, were cut 24 inches in thickness, less the joint.

The area occupied by the contractors for a stone yard was a strip of land about 1,100 feet long and 150 feet wide lying just back of the Fort Brady pier. All the cutting was done in this yard.

Description of plant.—During 1891 the plant consisted of 1 McMyler traveling crane, 1,000 feet of track for same, 1 stiff-legged derrick, and a one-story building of rough lumber, about 16 by 48 feet, containing office, storeroom, and blacksmith shop.

This portion of the plant was erected during June and July.

During April, May, and June, 1892, a stone-planing plant and 1 stiff-legged derrick were added to the plant. A small addition to the office building was also built.

With these additions the plant remained practically unchanged until the close of the contract.

The speed of the McMyler crane usually did not exceed 400 feet per minute, although capable of running 600 feet.

Its reach was 50 feet from its center, at which distance it was capable of raising 4 tons, which was about the weight of the ordinary header or stretcher in the rough. The capacity was rated at 10 tons, and it was supposed to be able to raise that weight when situated not more than 30 feet from its center.

This machine was very complete, being able to hoist, revolve, and raise or lower its boom when traveling at full speed.

The track for crane was 16 feet wide, a 5-inch rail weighing 85 pounds per yard being used. It ran parallel to the pier and about 70 feet from its face.

The stiff-legged derricks, each of 15 tons capacity, hoisted, raised, or lowered their booms and revolved by steam, an additional reversible rotary engine being used for the swinging gear. One end of each of the stiff legs rested on an A-shaped frame about 25 feet high, thus permitting the boom to make a complete revolution. The masts were about 65 feet in length, the booms 50 feet. Three-fourths-inch wire cables were used for hoisting.

They were situated one at each end of the track for traveling crane. The masts were each situated 18 feet from the face of the pier, thus enabling them to swing over a scow or vessel for loading or unloading stone. The one at the west end stood just in front of the old Fort Brady warehouse.

The stone-planing plant consisted of 4 stone planers, a 100-horse power cut-off engine, and boiler. They were situated in the center of the yard, on the south side of the track for crane and close to it, and were suitably housed by a one-story building of rough lumber covered with tar paper and battened. The building was steam heated and electric lighted.

The planers, known as the Merriman stone planer, were manufactured by the Lincoln Iron Works, of Rutland, Vt., and were completed, respectively, on May 11, June 6, and June 30, 1892, the last two being completed on the same date. The shafting, belting, and minor fittings, however, were not completed till July 7. The weight of each planer was about 48,000 pounds.

Work on the foundations was begun April 1. Their construction is similar to that of an iron planer. The engine and boiler were manufactured by the Erie Iron Works, the engine being high speed and of the Ball type. A more detailed account of the stone-planing plant and its capacity, etc., will be found under special report to Assistant Engineer E. S. Wheeler, dated July 3, 1893.

The entire yard was electric-lighted to facilitate work of traveling crane and planers during the night.

Besides the above-mentioned plant there was the usual amount of small tools furnished by the contractors. Each cutter, however, furnished his own tools, the contractors keeping them sharp and doing the ordinary repairing required.

Stone in the rough.—The stone were all quarried at Kelley Island by Hughes Bros. & Bangs, and transported by means of vessels.

The transportation, as nearly as can be ascertained, cost $1.80 per cubic yard, after deducting 2 inches from the length, breadth, and thickness of each piece in computing the volume, to allow for waste in cutting. Upon arriving at Sault Ste. Marie they were unloaded by the stiff-leg derricks, and were then either distributed to the planers, cutters, or were piled up for future use by the traveling crane. An account of operations at Kelleys Island will be found in special report to Assistant Engineer E. S. Wheeler, dated May 17, 1894.

The first cargo of stone to arrive was on the schooner *Fred J. Dunford*, July 17, 1891, the last for that season on the steam barge *Yosemite* and schooner *Chas. N. Ryan*, on October 23.

In 1892 the first cargo arrived on the *Yosemite* and *Ryan* April 27, the last on the schooner *Canton* October 18.

In 1893 the first cargo arrived on the schooners *Riverside* and *Wm. Home*, in tow of the tug *Alanson Sumner*, May 3, the last on the schooner *Mineral State* October 28.

The following table gives a synopsis of stone in the rough received:

Month.	1891.		1892.		1893.	
	Vessel loads.	Pieces.	Vessel loads.	Pieces.	Vessel loads.	Pieces.
April	....	....	2	323	....	....
May	....	....	11	1,354	11	1,522
June	....	....	10	1,346	11	1,484
July	2	286	9	1,154	9	1,164
August	3	377	11	1,640	6	828
September	4	536	12	1,700	4	572
October	5	713	1	43	2	152
Total	14	1,912	56	7,570	43	5,722

Total number of stone in the rough received, 15,204 pieces; total number of vessel loads, 113. Of these the following disposition was made:

Number used for face stone, 14,278 pieces; number rejected and used as backing (or thrown aside) after having been cut and accepted at the stone yard, having been broken by frost, careless handling, or other means, 97.

Number of rough and partially cut stone sent to lock pit for backing, 306; of these, however, many were only fragments, and probably the number of whole pieces would not exceed 200.

There would remain, therefore, about 629 pieces to account for. There are about that number left over, remaining in the stone yard. Of these probably, upon examination, a great many would be found to be culls.

The largest stone in the rough received contained 183 cubic feet, weighing about 28,760 pounds.

Stone planers.—A record of all work done by the stone-planing plant subsequent to July 1, 1892, was kept, a summary of which is contained in the following table:

Year and month.	Pieces planed.		Year and month.	Pieces planed.	
	Day watch.	Night watch.		Day watch.	Night watch.
1892.			1893—Continued.		
July	273	249	April	300	284
August	333	357	May	375	428
September	284	303	June	365	421
October	266	247	July	342	395
November	232	222	August	358	394
December	292	266	September	384	449
			October	363	480
Total	1,680	1,644	November	127	137
1893.			Total	2,633	[illegible]
March	19	20			

Total number planed, 8,965 pieces.

No work of any consequence was done before the date mentioned, owing to some trouble experienced in getting the two machines first erected to work in a satisfactory manner.

This trouble was finally found to be caused by their being run at too high a speed.

After the speed of the platen was reduced to 14½ feet per minute while cutting and 20 feet while reversed, no further trouble was experienced.

The fact that the night watch planed a greater number of pieces than the day watch can be accounted for by the fact that most of the large pieces, pattern stone, etc., were planed during the day, being a better class of work and consuming more time. In addition to this the day watch worked only eleven hours while the night watch worked eleven and a half hours.

All stone planed were afterwards finished by the cutters, the planers simply planing the stone down to their approximate dimensions. The planed surfaces coming in contact with the cement were bush-hammered or otherwise roughened, in order to insure a better bond with the cement when set.

During 1892 the planers were operated to January 1, 1893; during 1893 from March 30 to November 11.

The force required to operate the planers to their full capacity per day of twenty-two and one-half hours consisted of 8 planer men, 8 assistants, 2 tool-grinders, 1 blacksmith, 1 helper, 2 engine men, and usually 2 laborers employed at the refuse pile engaged in wheeling away stone chips from the pile where they were deposited by the traveling crane.

Stone cutting.—Stone cutting began July 30, 1891, with a force of 25 cutters, and continued till November 30, the average number of cutters employed being 47, the greatest number employed at any one time not exceeding 70.

The cutting was resumed April 5, 1892, with 31 cutters, and continued till December 10, the number of cutters averaging 71. The greatest number employed at any one time was 100.

The cutting was again resumed April 10, 1893, with 70 cutters, and continued till November 20, when the cutting was finished. The average number of cutters employed was 100. The greatest number of cutters employed at any one time during the whole progress of the work was 148, in September.

At the close of the season of 1891 the cutting was about 900 pieces in advance of the setting, of which about 450 remained piled in the stone yard during the winter. Of these a few were broken by frost during winter on account of not being sufficiently seasoned.

By the end of June, 1892, the cutting for the first five courses was practically completed with the exception of the piers and main miter wall. Work on the sixth course was well advanced.

When the cutting began in 1893 a little less than half of the stone cutting was finished. The cutting was about 2,100 pieces in advance of the setting, and the planers were about 630 pieces ahead of the cutters.

At the beginning of 1893 there were on hand about 1,700 pieces of stone in the rough, not including any spoiled, partially completed, or unfit for use.

On June 30 the cutting was practically completed for the first eighteen courses, excepting the miter walls. The cutters had nearly caught up with the planers. The stone cutting was well in advance of the setting until near the close of the work.

The largest size of cut stone used contained when cut 105.25 cubic feet, weighing 16,543 pounds. The smallest contained 5.88 cubic feet, weighing 924 pounds. The mean volume of the total number of pieces used was 35.44 cubic feet.

The following table gives a synopsis of stone cut:

Month.	1891.		1892.		1893.	
	Pieces.	Cubic yards.	Pieces.	Cubic yards.	Pieces.	Cubic yards.
April			177	249.29	595	768.19
May			463	624.89	1,007	1,355.81
June			459	594.12	1,142	1,562.52
July			1,000	1,313.01	1,047	1,394.42
August	256	319.34	1,069	1,420.12	1,194	1,532.80
September	401	537.11	953	1,268.22	991	1,124.90
October	401	549.58	834	1,152.89	969	1,110.44
November	257	355.33	556	795.15	309	461.11
December			198	251.80		
Total	1,315	1,761.36	5,709	7,669.49	7,254	9,310.19

Total number of pieces	14,278
Total amount ... cubic yards	18,741.04
Total cost, at $26 per cubic yard	$487,267.04
Amount of excess in length of headers and width of stretchers paid for as backing ... cubic yards	1,313
Cost of excess, at $6 per cubic yard	$7,878.00

The first scow load of cut stone was shipped to lock pit August 30, 1891.

Full-size patterns of sheet zinc, $\frac{1}{64}$ inch thickness, were used for cutting all stone of irregular shape.

During the first season the volume of a vessel load of stone in the rough was computed and calculations made to determine what percentage of stone in the rough was lost in the cutting.

The following table gives the result of these computations:

Classification.	Pieces computed	Excess paid for as backing.	Paid for as cut stone.	Lost in cutting.
		Per cent.	*Per cent.*	*Per cent.*
Common headers	45	3½	66	30½
Common stretchers	32	7½	69	23½
Miscellaneous pieces	29	4¼	68	27¾
Total cargo	106	5	68½	26½

These results would probably give a very close approximation to the amounts which they represent. The actual amount of excess and cut stone, as shown in the table preceding the last, will be found to be in nearly the same proportion as the per cent shown in the respective columns for the total cargo. Assuming, therefore, 26½ per cent to be loss in cutting, the volume of stone in the rough corresponding to the amount of cut stone actually laid would be 25,498 cubic yards. The amount of waste would be 6,757 cubic yards.

This amount would be considerably increased in bulk when scattered throughout the yard, probably between 10 and 15 per cent. Of this, about 750 cubic yards, in the form of planer chips, were removed from the yard for grading canal piers, and probably before the completion of the lock a great many of the spawls will be crushed and used for concrete.

The rest remained in the yard at the close of the work. The filling of the yard was still further increased about 600 cubic yards by ballast of sand for track of crane, planer foundations, waste in cutting rejected stone, etc. The total amount of filling at the stone yard was therefore increased about 7,450 cubic yards, approximately.

Method of piling cut stone.—The stone were piled along the south side of track for traveling crane. The sites selected were first graded. Timbers parallel to the track and to each other were then laid down on which to place the stone.

The maximum size of the piles was six pieces in height, four in width, and of varying lengths. The beds were separated by strips of wood 2 inches thick.

The piles were arranged so as to permit examination of each stone, and also to permit removals with safety.

Those stone remaining in the yard during winter were protected by having the lewis holes of the top layer of stones filled with dry sand covered with a thin layer of cement. The rest of them had the lewis holes covered with a 2-inch strip of wood, the space between the beds being calked with hay or straw. As an additional protection the top of the pile was covered with stable refuse about 6 inches in depth and the sides lightly banked with the same.

Lewis holes.—Two styles of lewis were used. The single round-pin lewis with its key, which was used for headers, stretchers, and stones of that class, required simply a hole drilled in the stone 1¼ inches in diameter and 7 inches in depth. The drilling was done at the rate paid common labor.

The ordinary rectangular keyed lewis of 3 parts, which was used for recess stone, or others of unusual weight, or where an unusual amount of labor had been expended, required a hole ⅞ by 2¾ inches at its top and ⅞ by 4½ inches at its bottom, with a depth of 5½ inches.

The cutting of this lewis hole required a stonecutter.

Tests.—Samples varying in weight from 15 to 30 pounds were obtained from each cargo of stone that arrived from Kelley Island, and also of such other stones as could be conveniently obtained.

These were labeled and their specific gravity afterwards obtained in order to get the weight per cubic foot.

The formula used was that recommended by Gen. Gilmore in his tests at Fort Tompkins, and given in the Annual Report of the Chief of Engineers for 1875. It was as follows: All sharp corners and loose particles were first removed. It was then carefully weighed in the air, after which it was immersed in water and allowed to remain until well saturated and all bubbling had ceased, when its weight was again taken. It was then removed and again weighed in its saturated condition, the superabundant water having first been removed. The specific gravity was then obtained by dividing the weight of the stone dry by its weight saturated minus the weight immersed.

In determining the weight per cubic foot the weight of the water was assumed to be 62½ pounds per cubic foot.

This method also furnished the means of obtaining the ratio of absorption, by which is meant the weight of water absorbed as compared with the weight of the dry stone. This, perhaps, might be more properly termed the avidity of absorption, as the period of immersion did not generally extend very long after all bubbling had ceased. Had the immersion occupied a longer period, it is possible that the ratio of absorption would have been somewhat increased.

The following table gives a summary of these tests:

Classification.	Samples tested.	Specific gravity.	Weight per cubic foot.	Samples tested.	Ratio of absorption.
			Pounds.		
Limestone from Kelley Island used for face stone for 800-foot lock	113	2.515	157.16	32	1:45
Limestone from Drummond Island, Michigan, used for backing for 800-foot lock	2	2.725	170.31	2	1:222
Limestone from Kelley Island or Marblehead used for face stone for lock of 1881 *	3	2.48	154.79	3	1:74
Limestone from Kelley Island or Marblehead, Ohio, used in old State lock	3	2.46	153.96	3	1:42
Sandstone taken from excavation for 800-foot lock †	3	2.52	157.50	3	1:555
Limestone used for face stone for lock at Sault Ste. Marie, Ontario	3	2.36	147.71	3	1:30
Limestone from Manitoulin Island, Ontario, used for backing for lock at Sault Ste Marie, Ontario ‡	2	2.81	175.50	2	1:1678
Red sandstone from Marquette, Mich	1	2.10	131.25	1	1:18

* Samples taken from the pile of rejected stone.
† Samples were very closed grain and hard.
‡ Samples were both water-worn.

A few special tests were made with samples of the Kelley Island stone in connection with those made for compression.

They are given in the following table:

Marks.	Specific gravity.	Weight.	Ratio of absorption.
		Pounds.	
1	2.53	158.19	1:163
3	2.51	157.12	1:60
4	2.50	156.25	1:103
6	2.53	158.12	1:63
17	2.57	160.62	1:123
22	2.46	153.75	1:43
27	2.39	149.38	1:82
30	2.45	153.12	1:37

These samples were afterwards cut in form of cubes and were tested as to their ability to resist compression, the column of marks corresponding to those of the following table.

These samples, as shown in the column of marks, were subsequently reduced to cubes and sent to the Watertown arsenal to be tested as to their ability to resist compression.

The following statement sent from Watertown arsenal shows the result of these tests:

Test No.	Marks.	Dimensions.			Sectional area.	First crack.	Ultimate strength.	
		Height.	Compressed surfaces.				Total.	Per square inch.
		Inches.	*Inches.*	*Inches.*	*Sq. ins.*	*Pounds.*	*Pounds.*	*Pounds.*
5663	0	2.98	2.98	2.98	8.88	105,800	105,800	11,910
5664	1	2.99	2.99	2.90	8.94	115,280	115,280	12,890
5665	3	2.98	2.99	2.98	8.88	112,490	112,490	12,670
5666	4	2.95	3	2.98	8.94	58,000	74,100	8,290
5667	6	3	2.97	2.97	8.82	89,000	96,900	10,980
5668	17	2.98	2.98	2.98	8.88	111,260	111,260	12,530
5669	22	2.97	2.96	2.99	8.85	111,590	111,590	12,610
5670	27	3	2.98	2.98	8.88	117,200	117,200	13,200
5671	30	2.98	2.98	2.99	8.91	128,200	129,300	14,510

Average ultimate strength, 12,477 pounds per square inch. The compressed surfaces were faced with plaster of paris.

The following table was taken from the records of the lock of 1881, for 1878, and is here inserted, as some of the samples were similar to some of those in the preceding tables:

Determination of the specific gravity and absorption of various stones.

Kind of stone.	Where found.	Specific gravity.	Weight per cubic foot (dry pounds).	Ratio of absorption.	Weight per cubic foot (saturated pounds).
Limestone	Bedford, Ind	2.403	149.8	1:27	155.6
Sandstone	Isle Royale, Michigan	2.660	165.8	1:220	166.5
Limestone	Drummond Island, Michigan	2.775	173	1:167	174.1
Trap	Marquette, Mich.	2.849	177.6	1:386	178.1
Sandstone	Sault Ste. Marie, Mich	2.473	154.2	1:62	156.7
Do	do	2.469	153.9	1:43	157.5
Do	do	2.513	156.7	1:57	159.4
Limestone	Bedford, Ind	2.430	151.5	1:32	156.2
Do	do	2.482	154.8	1:50	158
Trap	Huron, Ind	2.879	179.5	1:362	180
Granite	do	2.610	162.7	1:210	163.5
Limestone	Harmon City, Bay County, Mich	2.602	162.2	1:75	164.4
Do *	Marblehead, Ohio	2.427	151.7	1:32	156.4

* Taken from Gen. Gilmore's tables.

Weight of water, 62.35 pounds per cubic foot.

Force employed.—The daily average force for the season of active operations during the progress of the work was as follows:

Year.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1891	......	2	4	22	78	78	81	53	2
1892	53	96	123	146	162	137	128	105	87
1893	111	150	142	141	170	182	164	107	....

The greatest force employed at any one time was during September, 1893, when at times 200 men were employed. Their classification was as follows: One foreman, 148 cutters, 6 jackmen, 8 planermen, 8 assistants, 2 tool-grinders, 3 blacksmiths, 2 helpers, 6 enginemen, 2 firemen, 1 carpenter, 4 derrickmen, and 9 laborers engaged in loading cut stone, unloading stone in the rough, disposing of planer refuse, and carrying tools, water, patterns, etc.

Accidents and delays.—During 1891 but one delay occurred, when work was practically suspended from September 9 to 12 for want of stone in the rough, one of the vessels having been delayed.

From June 1 to 12, 1892, the cutters were on a strike for 45 cents per hour. They had been receiving 40 cents. The difficulty was finally compromised at 43 cents.

On June 18, 1893, the stiff-leg derrick at the lower end of the yard fell while unloading stone from the deck of the schooner *Chas. N. Ryan*. The mast and boom of the derrick were broken and the bulwarks of the schooner somewhat injured. The derrick was repaired and ready for service by July 6.

On June 12, 1893, one of the jackmen, while turning a stone, had his right leg badly crushed. This was the only accident of a serious nature that occurred at the stone yard.

During the progress of the work the crane and stone-planing plant were occasionally delayed by breakages, for which, in one or two instances, it was necessary to send to the manufacturers for duplicate parts. This, however, is to be expected of machinery of this class, especially when worked night and day; and, on the whole, the machinery behaved in a satisfactory manner.

The following item has been prepared by Assistant Engineer L. C. Sabin, who has had special charge of this part of the work:

Cement has been received from the contractors and issued for use during the year as follows:

	Barrels.
Portland	2,960
Natural	23,162

During the working season of 1893 the contractors, Hughes Bros. & Bangs, delivered 4,580 cubic yards of sand from Point aux Pins. A sample was taken from each cargo (90 yards), the samples being obtained by taking a small amount from each of ten or twelve places on the scow. At each place a hole was dug through the sand so that the full depth should be represented. These small amounts were thoroughly mixed to form the sample, which was afterwards dried and sifted. The average fineness for the season was as follows:

Table 1.

[Pebbles first removed by screen, holes about .25 inch square.]

Per cent passing sieve whose holes are about—			
0.08 inch square (No. 10).	0.033 inch square (No. 20).	0.022 inch square (No. 30).	0.17 inch square (No. 40).
96.6	91.8	79.1	44.7

Between 10 and 20 equals 4.8 per cent; 20 and 30 equals 12.7 per cent; 30 and 40 equals 34.4 per cent.

METHODS.

No radical changes have been made in the general scheme of testing or in the detail of manipulation. The ordinary acceptance tests consists of a test for tensile strength of every third barrel, a test for fineness of every thirteenth barrel, and a time of setting and pat test of every tenth barrel. The pat test is made with both hot and cool water.

RESULTS.

Although the requirements of the specifications are rigid, it was found necessary to reject but few barrels during the season. The most frequent cause of rejection of the foreign Portland cement was the damage it had received in transit. The number of barrels of either Portland or natural rejected on account of deficiency in tensile strength was very small indeed.

The average fineness of the cements tested during the working season of 1893 is shown in Table 2.

Table 2.

Brand.	Samples.	Barrels represented.	Mean per cent passing No. 100 sieve whose holes were 0.0059 by 0.0073 inch.
Hemmoor	113	3,527	92.9
Milwaukee	843	26,745	85.4

The regular acceptance tests occupy nearly all of the time during the working season. In the winter certain special tests are made to compare various brands of cement and kinds of sand and to investigate the effects of variations in manipulation to which the cement may be subjected either in the work or in testing. The results of some of these special tests were reported last year. The results obtained since that time are included in this report.

Series 1.—This table, giving the strength and fineness of several brands of Portland cement, was given in the last Annual Report, but is here repeated with the two-year results added. Twelve brands, of which samples were broken at all the ages given, are averaged at the bottom of the table and the highest and lowest noted for each case. The diagram which accompanies this series shows graphically the average rate of increase in strength for the twelve samples, and also gives two of the samples separately. It is seen that the mean strength 1 to 1 is appreciably higher at two years than at six months, the neat has gained nothing, and the 1 to 3 mortar shows a slight loss in strength; in fact, among fourteen samples tested 1 to 3, at six months and two years, only three gained any in that time, and this gain was in all cases far below the variations due to errors in experiments; on the other hand, among thirteen samples tested 1 to 1 there were but two which did not gain between six months and two years.

The results for samples 1 and 4 are given on the same diagram. These two samples were selected because they are about the same fineness, and one gives high results at short ages, but low at two years, while the other reverses this order. Among the short-time tests it appears that only one, namely 1 to 1, twenty-eight days, places No. 4 above No. 1. It should be stated, however, that these two samples were not tested on the same day.

Series 2.—The two-year results have been added to this series, and the conclusions seem to be that the difference in the strength of mortars made with the different varieties of fine sand are no greater than the differences due to varying the consistency of the mortar while using the same sand.

Series 2a.—This series is similar to Series 2, but includes limestone screenings and omits the sandstone screenings and the A sand. It includes mortars made of one part sand to one cement by weight as well as those of two parts sand. It is seen that the limestone-screenings give the highest results, especially with two parts sand, the higher percentage of sand bringing out the differences more plainly, as might be expected.

Series 3.—Series 3, giving the results obtained with seven brands of natural cement, neat, and with standard sand, were given last year and is here repeated with the two-year results added.

Series 16.—This series is for the purpose of comparing the values of four varieties of sand for use with natural cement, the different kinds being brought to the same fineness by sifting and remixing. The superiority of the screenings obtained in crushing limestone and sandstone was noted in the last Annual Report. The mortars from these two sands continued to increase in strength after one year, while the other varieties seem to have reached a maximum at six months or one year. The percentages of gain or loss after six months and one year are given in the table, and the diagram accompanying the tests clearly brings out the differences.

Series 17.—When these same sands are used with Portland cement, Series 17 shows that the limestone and sandstone screenings give the highest results, as they do with natural cement, but unlike the latter the mortars with Portland do not gain any between the ages of one and two years.

Series 18 and 19.—The two year results for these series do not differ materially from those obtained at one year. Sand of the composition $m^{10}f^{0}v^{0}$ is tested here only for the sake of comparison, as it is impracticable to obtain it for use in construction. The indications are that the percentage of grains of size between 20 and 30 (passing holes 0.033 inch square and which will not pass holes 0.022 inch square) should be something more than 10 and the percentage of size passing 40 (holes 0.017 inch square) should be something less than 60.

Series 18a and 19a.—These two series have the same purpose as 18 and 19, but include another size of grain, namely, passing holes 0.08 inch square and not passing holes 0.033 inch square, this size being included because it occurs in the sand as used in the work. The five compositions chosen are typical of the sand as received; the mean fineness of 4,580 cubic yards received during the working season of 1893 being approximately $c^{5}m^{15}f^{35}v^{45}$. The strengths obtained at six months with the various compositions do not vary greatly.

Series 20.—The two year results for this series are added, and it appears that the mortars made with the coarser sands have increased rather more than have the fine-sand mortars in the interval between six months and two years, so that the superiority of the coarse sand is more apparent at two years than at six months. The remarkably high strength of 812 pounds per square inch for briquets containing three parts sand is worthy of note. The broken section of these coarse sand briquets showed that the sand grains had broken and not pulled out, such a firm hold had the cement obtained.

Series 21.—Tables 1*a* and 2*a* give the strength at two years of various mortars made with natural and Portland cements with Point aux Pins sand. The results obtained at six months were given in the last Annual Report. The gain or loss between six months and two years is indicated in the tables. By averaging the results for each proportion of sand separately it may be seen that for natural cement with one part sand, by weight, there is an average loss of about 5 per cent and for other proportions a gain of from 2 to 3 per cent; for Portland the 1 to 3 proportion shows a loss of 1 per cent, while other proportions show a gain of from 8 to 64 per cent, the largest percentage gain being for 10 parts sand to 1 cement.

In the last Annual Report, under Series 21, a table was included giving the cost of mortars of different proportions, the quantities being derived from experiments on a few of the proportions only. Since then, in making mortars in quantities of about 3.5 cubic feet containing different proportions of sand and cement, the amounts of each required for a given quantity of stiff mortar were noted, and from these experiments Table 3*a* is derived, which should supersede Table 3 in the last report. The inaccuracies in Table 3 arose, first, from the fact that in the few experiments made the change of volume of the sand with the presence of moisture was not duly considered; and, second, from the incorrect assumption that when the amount of cement used was insufficient to fill the voids in the sand the amount of mortar made was not in excess of the bulk of the sand. By referring to Diagram 3*a*, which is derived from

Tables 1*a*, 2*a*, and 3*a*, it may be seen that the new results do not reverse the relative positions of the curves indicating economy. Diagram 1*a* gives the cubic feet of mortar made to 1 barrel of cement and Diagram 2*a* gives the cost of mortars as in Table 3*a*.

Series 25a 25b and 26a.—These series are similar to 25, 26, and 31, which were reported a year ago and refer to the regauging of mortars. The results show that the variations in consistency within the limits used do not cause notable differences in strength at one year; that continuous gauging for four instead of two minutes does not increase the resulting strength very materially, but that eight minutes' gauging is decidedly advantageous and that this extra amount of gauging makes the mortar appreciably less stiff.

As to allowing the mortar to stand some time before using, it appears that moderately slow-setting natural cements may be left as much as two hours without regauging and then give good results on being regauged and used; that they may be left even as long as four hours without detriment, provided they are regauged frequently during that time and sufficient water is added to keep the mortar plastic. The slow-setting Portland mortar was not injured by allowing it to stand five hours even if not regauged in the interval; but with all the mortars tested it appears that frequent regauging and the addition of water as needed is preferable. Further tests have been started to show the relative behavior of slow and quick setting cements, of rich and poor mortars, and of neat cement mortars when subjected to regauging.

Series 27.—This series gives the rates of increase in strength of two samples of natural cement from one day to six months neat and the strengths with one part sand at twenty-eight days to two years. The two samples have nearly the same strength in general, though one is 28 pounds stronger at five days than the other. The gains between one day and two days and between seven and ten days are not great. Also there is apparently no gain in strength after three months within the limits of time used either with neat cement or half sand. The results may be plainly seen in the diagram.

Series 28.—This series gives the results of a few tests in warm water. An inspection of the diagram will show that this sample of natural cement when mixed with one part sand, by weight, gained as much strength in water at 100° F. in ten days as it did in twenty-eight days at 60° F., and that the strength at four days in warm water was about the same as that at seven days in cool water.

Series 29.—This series is similar to 28, but relates to Portland cement. Here it is seen that the cool-water tests are above the warm for neat cement up to seven or eight days, while for 1 to 3 mortar the warm tests are above for about the same length of time.

Series 31.—This series deals with the regauging of mortars, as do 25*a*, 25*b*, and 26*a*, the one-year results having been added since the last report. The only difference worthy of note is that the result obtained at one year for mortar which had stood three hours without regauging is somewhat less than the result with fresh mortar. This is apparently more severe treatment than allowing the mortar to stand five hours when regauged every hour, though the differences are not great.

Series 33a.—The tests recorded in Series 33, under the heads of 33*a*, 33*b*, etc., were made to investigate the effects of variations in the methods of manipulation and the subsequent treatment of the briquets. They were designed to relate only to methods of testing, but in some cases the results indicate the proper treatment of mortars for actual use. At the time of starting the tests there were four molders who were making briquets interchangeably. The first test suggested, then, was to find the relative strengths of briquets made by these molders. Three of the molders made similar briquets one day and one of these made by the fourth another day. It is seen that similar briquets made the same day by different molders do not differ much in strength but that briquets made on different days by the same molder may differ considerably.

These four molders have all been trained in the same way, one copying from another, and the inference must not be drawn that what has been called the "personal equation" may be disregarded in comparing the results of different experimenters working apart even though they may be following the same rules.

Series 33b.—These tests were originally designed to show what difference in tensile strength might result from variations in the consistency of the mortar, the briquets being broken at the usual ages of 1, 7 and 28 days. But they were extended so as to indicate whether the differences so obtained would exist at three months, six months, etc. These tests are all made of the same brand of natural cement. Tables 1 and 3 and Diagram 1, made from these tables, show that for neat cement the absolute strengths and the variations in strength due to differences in consistency are about the same at seven days as at one day. The stiffest or driest mortar used gave the highest result, and the thinnest mortar the lowest, except in one case, at seven days; the mortar containing 36 per cent water gave slightly lower strength than that containing 40 per cent. The twenty-eight day results in Table 1 exhibit greater variations than the one and seven day results, but in Table 3 this is not the case. The three months' results in Table 1 indicate that the differences in strength due to variations in consistency are rapidly disappearing with age.

Tables 2 and 5 and Diagrams 2 and 3 give the results obtained with mortars composed of one part by weight of standard sand to one part of natural cement. It is seen that at seven days the differences are considerable and that the mortars made with about 17 per cent of water give the highest results; at twenty-eight days the differences are still greater (referring to absolute strength rather than percentages), but the maximum strength is obtained by the mortar made with 18 per cent of water; at six months those mortars having much less than 18 per cent water have gained comparatively little in the last three months, while those containing about 22 per cent water give the maximum strength, and the mortar containing 26 per cent is not far below. Diagrams 4, 5, and 6 present these results in a different way.

Tables 4 and 6 and Diagram No. 7 show that in tests of mortars with two parts sand to one cement, the highest strength at twenty-eight days is obtained with a rather dry mortar, but that as with the 1 to 1 mortar those containing a large amount or water becomes the stronger in time—the maximum at six months and one year for sample 16 R being obtained with about 16 per cent water and for sample 15 R with about 17 or 18 per cent.

Series 33c.—These tests were made to show the effect of using cold materials and gauging in a cold room. Tables 1 to 7, inclusive, refer to natural cement and Table 8 to Portland. The results of Tables 1, 2, and 3 are plotted on Diagram No. 1 and those of 4 to 7, inclusive, on Diagram No. 2, while Table 8 is plotted on Diagram No. 3. The curves are all numbered; the odd numbers refer to briquets made in the cold and even numbers to briquets made in the ordinary temperature of 65° to 70°. In general, the briquets made in the low temperature (above freezing) were stronger than those made at 65°. Sometimes the difference was not very great and sometimes the warm briquets were ahead at one day and seven days, but at twenty-eight days the cold-made briquets were nearly always in the lead, and this difference held good for three and six months. The latter part of Table 2 indicates that if the briquets are allowed to stay in the cold air for twenty-four hours or more it tends to counteract the good effects of molding in the cold, and this conclusion is borne out by other tests. Thus there is more difference between curves 15 and 16 on Diagram 2 than between curves 17 and 18, the briquets whose results are represented by the former being left in the cold air twelve hours and the others twenty-four hours.

Series 33d.—It is often the case that tests are conducted in a room where no special pains are taken to prevent the temperature falling during the night. Some have claimed that low temperatures for the water of immersion give low tensile strengths and others have considered that the reverse was the case. The tests given in 33d were made to determine this question for some of the natural cements. The results given in Tables 1 to 5 are collected in Table 6 and wherever possible results on similar mortars have been combined. Diagram No. 1 shows the results. It would appear from this diagram that for briquets made from this brand of cement and broken at 7 days it makes little difference what the temperature of the water of immersion may be between the limits of 50° and 70° F.; that it is possible that the briquets of neat cement gain a trifle more strength in water at 38° F., and that both neat cement and 1 to 1 mortars gain a trifle more in water at 80° than they do in temperatures between the above-named limits. Between fourteen and twenty-eight days the neat cement mortar gains very little if kept in a temperature lower than 60°, but in water above that temperature the gain is in a way proportional to the temperature. The 1 to 1 mortar gains very little in this interval if kept in water at 38° F., but the gain increases with the temperature of the water. At two hundred and twenty-eight days it seems to make little difference what the temperature of the water is between the limits of 38 and 50, but the gain increases with the temperature if above 50°. The gain of the 1 to 1 mortar between seven and twenty-eight days is small in water at 38° F., but the gain increases rapidly as the temperature of the water is increased.

Table 1 and Diagram 2 give the results at seven days with five samples, two of the samples being of the same brand. Here it is also seen that for neat cement at seven days the strength is practically the same, whatever may be the temperature of the mortar of immersion between the limits of 50° and 70°. Tables 8, 9, and 10, and Diagrams 3, 4, and 5, show the results obtained with longer time tests. The briquets whose results are given in these three tables were in tanks containing many other briquets, and the water in the tanks was not changed frequently enough to insure it being constantly fresh. These results must therefore be taken with some allowance, but it would appear that the differences in strength due to variations of 15° in the water of immersion are not very great. In all cases the warmer water gave a somewhat higher strength at three months.

The briquets whose results are given in Table 11 were immersed in tanks in which the water had become stale from long use. It is seen that tank "U" gave much lower results and tank "H" higher results than would be expected from their respective temperatures. It is thus apparent that to have the water in the tanks renewed frequently is of even greater importance than that the temperatures should be the same.

Series 33f.—It is the general practice to leave the briquets twenty-four hours in moist air before immersion, but this practice is sometimes departed from. Briquets to be broken at one day are generally immersed as soon as set hard enough. This series gives the results obtained by immersing at different lengths of time after molding. The diagram indicates that varying the treatment in this regard may affect different mortars differently, but as in all cases the curves are nearly horizontal between twenty-four and forty-eight hours it would seem that this were the best length of time to allow in moist air, since then a slight variation in the specified time of immersion would result in little, if any, difference in strength.

Series 33g.—This series was made to show whether it was important that the air in which the briquets are stored for the usual twenty-four hours should be kept moist. It would seem that the drier the briquets are kept for the first twenty-four hours the higher will be the strength at seven days. With briquets of 1 to 1 mortar the difference seems to be very small, but somewhat greater for neat cement briquets.

Series 33h.—It is generally supposed that variations in the method of filling the mold is the cause of the greatest discrepancies between results of different operators. To indicate whether this is the case the briquets in this series were all made in the same way in the particulars of gauging and of the final finishing of the briquets; that is, they were all pressed heavily on top with the trowel; but half of them were made in the usual way by putting small amounts of mortar in the mold at a time and pressing down each layer either with fingers or trowel, while the other half had little work expended on them except the final pressure on top. The results would seem to indicate that these variations in method did not make important differences in the strength obtained at seven and fourteen days, but the tests are but few and do not deserve great weight.

Series 33i.—The briquets of this series were all made in air of the same temperature, but the temperature of the cement, sand, and water varied, being about 35° F. for part of the briquets and about 65° for the others. From these experiments it can not be said that such a variation as 30° in the temperature of the materials affects the strength of the briquets so long as the temperature of the air is constant.

Series 35 and 35a.—These series are similar to Series 30 given in the last annual report, and refer to the mixing of Portland and natural cements. The conclusion reached for Series 30 was that the full strength of the two samples was not developed when they were mixed. In Series 35 two different samples are used, and the results obtained at one year indicate that the mixture develops fully as much strength as the mean of the Portland and natural separately. Series 35a points to a similar conclusion. Series 35 and 35a are made with the same brands, but with different samples.

Series 37.—Among many tests made with hot water, Series 37 gives a few of those made to determine the effect of variations in treatment before immersion. When the temperature of the water of immersion was 60° C. the highest result at seven days was obtained by leaving the briquets twenty hours in moist air and four hours in the vapor. The nine-day results indicate that it makes little difference whether the briquets are left ten hours or twenty-four hours in moist air, or zero or four hours in vapor. For 80° C. the highest results were obtained by immersing at the end of twenty-four hours.

Series 38.—This series gives the results obtained by immersing in hot water briquets from several brands of natural cement. It is seen that all but the "Bu" brand stood a temperature of 60° C. fairly well, and this was the only sample which gave a very low strength tested cold at two years. The only sample which stood well a temperature of 80° C. was the "An" brand. It appears that for 80° C. the briquets should not be subjected to the vapor more than three hours.

Series 40.—This series gives the rate of increase in strength of a certain sample of natural cement mixed with 1, 2, and 3 parts of standard sand. It appears that the 1 to 1 mortar gains very little between five months and nine months and that the 1 to 2 and 1 to 3 mortars gain nothing between four months and ten months.

Series 45.—It is a common practice to heat the materials for making mortar when working at a temperature below 32° F. It has been questioned whether this was good practice. Series 45 gives a few results on the subject. Line 1 in the table is from briquets made of mortar which at the time of making was considered too dry and those in line 2 had more water added. As in all other respects these two cases were the same the higher strength of No. 1 indicates that the mortar should not be very moist when work is done in low temperatures; this result might have been predicted. Comparing 2 with 4 and 3 with 5 shows the same. Comparing the mean of 2 and 4 with the mean of 3 and 5 and the mean of 8 and 10 with the mean of 9 and 11 it appears that with either 1 to 1 or 1 to 2 mortar it makes little difference whether the materials are heated when the mortar is to be exposed to the open air.

Comparing 6 with 7 and 12 with 13 it appears that for both 1 to 1 and 1 to 2 mortars it is somewhat better to heat the materials when the mortar is to harden in cold water.

Series 46.—This series is similar to 45, but refers to natural cement. It appears that in all cases a better result was obtained by heating the materials. It should be noticed that the briquets hardened in cold water developed but little strength.

Series 50.—This series was made to show the relative effects of exposing the briquets to the dry air of a room to harden and of immersing them as usual. The results in any given line of the table are from briquets made in the same way, part of them being immersed in water at a temperature between 60 and 70° F. while the rest were put on shelves in the laboratory. Diagram No. 1 shows that for this sample of natural cement more strength is attained in three months in the dry air than in water, but the six months' results, which are not plotted, reverse this conclusion for neat cement. Diagram 2 is from the results given in lines three and four. It is seen that for this brand of Portland cement a 1 to 1 mortar gives higher results in dry air at seven days, but between the ages of three weeks and three months there appears to be little difference whether the briquets have hardened in dry air or in water; at six months the dry air briquets are again ahead. A 1 to 2 mortar seems to gain a trifle more strength in air than in water, at least up to six months.

Diagram No. 3 shows that this sample of natural cement will not harden well in dry air. The two curves are about the same at twenty-eight days, but the briquets in dry air gain nothing between twenty-eight days and three months. Diagram No. 4 shows that this sample of Portland, R, 18R, behaves well in dry air. It would also appear that the amount of water required to give the best results follows about the same law whether the briquets are hardened in air or water.

Series 51a—Series 51 is similar to Series 33, dealing with variations in manipulation. Like Series 33 it is divided into several parts, called 51a, 51b, etc.

Series 51a corresponds to Series 33b, referring to variations in consistency of the mortar. Diagram 1 gives the results of Table 1, obtained with neat cement mortar of brand "Ln." The differences due to consistency are greater than those obtained in Series 33b for neat cement mortar, and these differences do not seem to diminish with age up to three months, the limit of this experiment. Diagram No. 2, from Tables 2 and 3, shows that for 1 to 1 mortar the differences do not diminish, but rather increase with age up to three months, and that the thinner mortars gain more with age than do the stiff ones, so that while 15 per cent water gives the maximum strength at seven days, 20 per cent gives the maxium at three months. With the 1 to 2 mortar the maximum strengths are obtained at seven days, twenty-eight days, and three months by 8½, 10½, and 12½ per cent of water, respectively, and in this case also the differences obtained at seven days do not diminish.

Diagrams 3 and 4, from Tables 4 and 5, give the results obtained with five samples representing three brands of natural cement. The curves in the diagram are underlined at the points where the mortar was of the consistency ordinarily used here for briquets. It is seen that the maximum strength at seven and twenty-eight days is slightly to the left of this point; that is, that a trifle stiffer mortar than that which is considered right for briquets would give somewhat higher results at seven and twenty-eight days. It is also apparent that all brands are not affected alike by given differences in consistency; sample Gn 84R being affected the least and Hn 26s the most, by given variations in the amount of water used.

Series 51b.—This series is similar to 33d, and refers to the temperature of the water in which the briquets are stored. Diagram No. 1, from Table 1, might well be studied in connection with Diagram 1 of Series 33d. The former is more complete, as it includes one day and two months tests. At one day the coldest tank gives the highest result, at seven days there is little difference, due to temperature, but at fourteen and twenty-eight days the warmer tanks are ahead, with little difference between 40° and 50°, while at two months the curve becomes a straight line, or the strengths vary directly as the temperature between the limits of 40° and 80°. Diagram No. 2, from Table 2, shows a similar result for another brand, except that for this sample it does not appear that a temperature as high as 80° C. is desirable. This result may possibly be due to some other cause than temperature, though with the method of making the briquets it is not apparent how another element could enter to such an extent.

Diagram 3, from Table 3, shows a similar result for mortar made with one part sand, except that at seven days the higher tanks gave slightly higher results than the cold ones, and at two months the strength attained in 80° is somewhat lower and than attained in 40° is somewhat higher than they should be to make the strength vary directly with the temperature; in other words, there are indications that the differences in strength due to differences in temperature reached a maximum at or before two months. Diagram 4, from Table 4, gives the results obtained with 1 to 3 mortar. The curves are similar to the previous ones, except that it appears that the maximum difference had not yet been attained at two months; the two-months' curve is similar to the twenty-eight-day curve in Diagram 1.

Series 51c.—This series shows the effect of leaving the briquets in moist air different lengths of time before immersion and is similar to Series 33f. In Table 1 five of each set of briquets were broken directly from the damp closet at ages varying from twenty hours to five days, and the other five were immersed until they were seven days old; it was thus impossible to determine how much the briquets gained or lost by immersion. It appears that for the sample used neat briquets suffer a loss of strength by immersion which they do not regain for some time. Thus briquets broken at twenty hours without immersion were a trifle stronger than those broken at seven days which had been immersed for the last six and one-fourth days. With briquets of 1 to 1 mortar it appears that if immersed at the end of four days they gain by the extra three days' age just about the loss due to immersion and if immersed ealier than that the gain is greater than the loss, while if immersed later the gain is not equal to the loss. Table 2 and the diagram show that for neat, 1-1 and 1-3 mortars the strength at seven and twenty-eight days is greater the longer the briquets are allowed to remain in the moist air and that the effect is greatest on neat cement mortars.

Series 51d.—This series is similar to 33g, and shows the effect of varying the amount of moisture given the briquets the first twenty-four hours after made. First it may be said that good results are not obtained by immersing the briquets as soon as made. As to whether they shall be kept in dry or moist air for twenty-four hours, the difference in strength at seven and twenty-eight days due to such variations seems to be small. At twenty-eight days the briquets kept in moist air for twenty-four hours are in the lead, as are the seven-day briquets of neat cement. Mortar briquets broken at seven days seem to reach a slightly higher strength if kept in dry air. These conclusions are not entirely in accord with those deduced for series 33g, but, as said above, the variations in strength are not large.

This report concerning dredging operations has been prepared by Assistant Engineer Joseph Ripley, who has had special charge of this part of the work.

DEEPENING CANAL PRISM.

This work consists in the removal of about 280,000 cubic yards of material, principally Potsdam sandstone in situ, so as to deepen the water in the canal above the locks to 25 feet. The general depth of cutting is nearly 9 feet.

The time for finishing the work has been extended from June 30, 1894, to July 1, 1895.

Under contracts dated July 14, 1892, Messrs. Dunbar and Sullivan have worked from 1 to 5 dredges and 2 drill boats.

Last September they finished dredging the north half of the canal. The raft bars were then swung at 17 feet, to assure the safety of passing boats.

Dredging was discontinued for the winter December 13 and resumed again March 16. Four-fifths of the total area of 860,000 square feet has been dredged over.

Summary of dredging.

Date.	Section 1, rate $1.53 per cubic yard, bank measurement.		Section 2, rate $1.47 per cubic yard, bank measurement.	
	Scow measurement.	Estimated bank measurement.	Scow measurement.	Estimated bank measurement.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
August, 1892, to June 30, 1893	49, 220	33, 730	77, 512	48, 774
July 1, 1393, to June 30, 1894	50, 944	38, 346	109, 654	62, 177

Summary of drilling.

Date.	Section 1.		Section 2.	
	Holes drilled.	Dynamite used.	Holes drilled.	Dynamite used.
		Pounds.		*Pounds.*
August, 1892, to June 30, 1893	1, 865	25, 565	5, 865	83, 320
July 1, 1893, to June 30, 1894	2,361	35, 330	5, 156	75, 755

The dynamite was 70 per cent of nitroglycerine. The holes were 5 feet apart, and the average depth of drilling was 11 feet.

The average charge was 14½ pounds of dynamite, which broke 10 cubic yards of rock at each blast.

The monthly estimates were generally made by deducting 30 per cent from the scow measurements.

December 16 to 20 a thorough survey was made from the head of the canal to the basin. Over 4,000 soundings, 10 by 20 feet apart, were taken through the ice. The usual computations and maps were made for the season's estimates.

Four thousand soundings were also taken on the lower approach to the locks. The ice augers were used for boring the holes through the ice.

On May 14, while dumping scow No. 6 at the head of the rapids, the scow filled and sank. The scowman, Joseph Walker, was drowned.

Under contract dated June 17, 1893 for widening the channel at "The Elbow," Lake George, the contractor, R. J. Cram, began dredging on July 3 and finished November 25, 1893. Four cuts were made on the west side of the channel, each one about 22 feet wide, and varying from 1,100 to 2,500 feet long, making the channel at least 200 feet wide and 17 feet deep.

Fifty-nine thousand eight hundred and forty-three cubic yards, scow measurement, were excavated, at a cost of $7,661.42.

I was assisted by Assistant Engineer Dixon and Inspector Morrison.

There have been employed upon this work at different times during the year Assistant Engineers Joseph Ripley, J. L. Callard, Frank Reed, L. C. Sabm, B. Rohnert, F. C. Shenehon, and C. Y. Dixon; Clerk Common, Draftsman Mangelsdorf, and Inspector L. P. Morrison.

Very respectfully, your obedient servant,

E. S. WHEELER,
Assistant Engineer, etc.

Col. O. M. POE,
Corps of Engineers, U. S. A.

SERIES 1.—*Strength of mortars and fineness of fifteen brands of Portland cement.*

[Results in any single column which bear the same letter are from briquets made the same day and immersed in the same tank until broken.]

Cement.		Fineness (per cent passing).		Tensile strength (pounds per square inch).					
				Neat cement.				1 part sand to 1 cement (by weight).	
Brand.	Sample.	Sieve No. 100 (holes 0.0065 inch square).	Sieve No. 120 (holes 0.0046 inch square).	7 days.	28 days.	6 months.	2 years.	7 days.	28 days.
H*	5s	....	....	497c	570a	619a	633c	501a	650a
H*	21s	90.7	82.6	567a	710d	736c	703a	566b	669b
R*	300s	....	....	523a	619a	717a	676a	525b	591b
I*	8s	89.5	76.4	469a	562a	669a	748a	486b	563b
P*	2	....	....	516b	626a	721a	638b	467c	653c
K*	3	81.3	67.7	518b	628b	646b	643b	477c	606c
F*	4	86.7	79	387c	575b	685b	728c	404a	614a
C*	12s	86.6	76	532b	711b	797b	790b	502c	621c
A	11s	88.8	81.6	438c	566d	....	....	426a	620a
N*	18s	83	70.4	403c	479c	574c	637c	399a	546a
J*	17s	89	79.1	574b	743d	737c	767b	503c	665c
A*	20s	84.5	73.8	556a	637d	691c	681a	498b	616b
L	22s	92.7	87	....	....	....	....	....	....
G*	1	92	80	542a	616a	732a	730a	469b	560b
L	7s	87.4	76	402b	483b	568c	629c	380c	....
B	16s	74.4	65.7	361c	402b	544b	....	330a	444a
E	23s	84.8	74.3	....	....	....	712b	....	....
D	24s	71.5	62	....	....	....	644c	....	....
Sum	....	....	....	6,084	7,476	8,324	8,374	5,798	7,354
Mean	....	....	....	507	623	694	698	484	613
Highest	....	....	....	574 (17s)	713 (17s)	797 (12s)	790 (12s)	566 (21s)	669 (21s)
Lowest	....	....	....	387 (7)	479 (18s)	574 (18s)	623 (5s)	399 (18s)	546 (18s)

SERIES 1.—*Strength of mortars, etc.*—Continued.

Cement.		Tensile strength (pounds per square inch).								
Brand.	Sample.	1 part sand to 1 cement (by weight).		3 sand to 1 cement (by weight).					4 sand to 1 cement.	5 sand to 1 cement.
		6 months.	2 years.	7 days.	28 days.	6 months.	1 year.	2 years.	2 years.	2 years.
H*	5s	740c	763c	176c	272a	456c	398c	384c	....	....
H*	21s	722a	840a	197a	266b	434a	395a	350a	283a	228a
R*	300s	756a	813a	202a	255b	384a	394a	370a	280a	224a
I*	8s	727a	796a	177a	250b	387a	388a	390a	....	215a
P*	2	752b	814b	148b	251c	381b	388b	365b	268	....
K*	3	722b	860b	164b	237c	367b	383b	354b	....	....
F*	4	761c	855c	101c	212a	385c	379c	382c	....	....
C*	12s	756b	687b	144b	219c	362b	376b	332b	233a	....
A	11s	698c	....	188c	275a	361c	362c	....	....	....
N*	18s	650c	649c	133c	185a	311c	351c	318c	....	....
J*	17s	743b	764b	181b	261c	392b	350b	343b	249a	....
A*	20s	675a	795a	150a	227b	374a	350a	327a	....	198a
L	22s	....	....	235b	289d	368d	....	369d	....	....
G*	1	661a	704a	175a	240b	338a	333a	311a	....	184a
L	7s	634b	763c	....	201c	....	....	405c	....	....
B	16s	574c	....	88c	148a	298c	319c	....	....	....
E	23s	....	781b	....	....	353b	345b	322b	....	....
D	24s	....	668c	....	....	....	....	252c	....	....
Sum	....	8,665	9,345	1,948	2,874	4,571	4,485	4,226	....	....
Mean	....	722	779	162	240	381	374	352	....	....
Highest	....	761	860	202	272	456	398	390	....	....
		(4)	(3)	(300s)	(5s)	(5s)	(5s)	(8s)		
Lowest	....	650	649	101	185	311	333	252	....	....
		(18s)	(18s)	(4)	(18s)	(18s)	(1)	(24s)		

SERIES 2.—*Values of different varieties of fine sand for use in Portland cement mortar.*

Reference.	Sand.			Water (per cent of dry ingredients).	Date made (October, 1891).	Age of briquets.	Tensile strength.				Molder.	Tank.	Remarks.
	Kind.	Fineness.	Parts to 1 of cement (by weight).				Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	
							Lbs.	*Lbs.*	*Lbs.*				
1	S. S.	Pass 40	2	18.5	9	6 mos.	388	407	373	5	N	O. C	
2	S. S.	40–100	2	17.5	9	6 mos.	478	486	468	5	N	O. C	
3	W. P.	Pass 40	2	13.3	9	6 mos.	433	461	406	5	N	O. C	
4	P. P.	Pass 40	2	12.1	9	6 mos.	382	405	361	5	N	O. C	
5	A.	Pass 40	2	13.3	9	6 mos.	398	422	370	5	N	O. C	
6	S. S.	Pass 40	2	16.7	8	1 year.	478	523	388	5	N	O. C	Mortar rather dry.
7	S. S.	Pass 40	2	17.5	8	1 year.	430	462	387	5	N	O. C	Mortar trifle dry.
8	S. S.	40–100	2	17.5	8	1 year.	489	534	444	10	N	O. C	
9	W. P.	Pass 40	2	13.3	8	1 year.	421	457	390	10	N	O. C	
10	P. P.	Pass 40	2	12.1	8	1 year.	406	422	378	10	N	O. C	
11	A.	Pass 40	2	13.3	8	1 year.	403	449	304	10	N	O. C	
12	S. S.	Pass 40	2	18.5	9	2 years	470	504	429	5	N	O. C	
13	S. S.	40–100	2	17.5	9	2 years	539	566	492	5	N	O. C	
14	W. P.	Pass 40	2	13.3	9	2 years	445	462	434	5	N	O. C	
15	P. P.	Pass 40	2	12.1	9	2 years	437	478	410	5	N	O. C	
16	A.	Pass 40	2	13.3	9	2 years	506	517	500	4	N	O. C	
17	S. S.	Pass 40	2	13.3	7	2 years	547	590	437	5	N	O. C	Mortar very dry.
18	S. S.	Pass 40	2	14.8	7	2 years	563	602	538	5	N	O. C	Do.
19	S. S.	40–100	2	14.8	7	2 years	587	629	539	10	N	O. C	Mortar dry.
20	W. P.	Pass 40	2	14.8	7	2 years	419	454	401	5	N	O. C	Mortar moist.
21	W. P.	Pass 40	2	13.3	7	2 years	434	467	390	5	N	O. C	Mortar O K.
22	P. P.	Pass 40	2	13.3	7	2 years	400	420	378	10	N	O. C	Mortar rather moist.
23	A.	Pass 40	2	13.3	7	2 years	443	481	410	10	N	O. C	Mortar O K.

NOTE.—S. S., sandstone screenings from rock crusher (Potsdam sandstone). W. P., natural sand from open-bank water-power canal. P. P., pumped from bed of river at Point aux Pins. A., clean white sand used for pointing on lock of 1881. Fineness 40–100, passing No. 40 sieve (holes about 0.015 inch square) and retained on No. 100 sieve (holes 0.0065 inch square).

SERIES 2a.—*Values of different varieties of fine sand for Portland cement mortar.*

References.	Sand.			Six months.					
	Kind.	Fineness.	Parts to 1 of cement.	Date made (March 1893).	Water (per cent of dry ingredients).	Strength.			
						Mean.	Highest.	Lowest.	Number averaged.
	a	b	c	d	e	f	g	h	i
						Pounds.	*Pounds.*	*Pounds.*	
1	P. P.	Pass 40	1	6	14	715	776	638	10
2	W. P.	Pass 40	1	6	14.5	664	717	623	10
3	L. S.	Pass 40	1	6	18.25	721	777	628	10
4	L. S.	40–100	1	6	17.5	753	816	698	10
5	P. P.	Pass 40	2	10	12.4	491	509	480	5
6	W. P.	Pass 40	2	10	12.7	442	476	417	5
7	L. S.	Pass 40	2	10	17.7	531	580	454	5
8	L. S.	40–100	2	10	17	597	640	554	5
9	P. P.	Pass 40	2	9	12.4	460	504	410	5
10	W. P.	Pass 40	2	9	12.7	420	440	400	5
11	L. S.	Pass 40	2	9	*16.5	552	591	538	5
12	L. S.	40–100	2	9	*15.8	591	620	551	5

* Trifle dry.

SERIES 3.—*Strength of mortars and fineness of seven brands of natural cement.*

[Results in any single column which bear the same letter are from briquets made the same day and immersed in the same tank until broken.]

Cement.		Fineness (per cent passing).		Tensile strength (pounds per square inch).							
Brand.	Sample.	Sieve No. 100 (holes 0.0065 inch square).	Sieve No. 120 (holes 0.0046 inch square).	Neat cement.						1 part sand to 1 cement (by weight).	
				7 days.	28 days.	3 months.	6 months.	1 year.	2 years.	7 days.	28 days.
Cn	14s	87.7	76.8	149c	152c	....	346b	464a	384b	149a	181b
An	13s	86.6	80.3	157c	173c	272a	399a	462b	549a	....	208a
Fn	19s	87.8	80.7	120c	185c	236a	310a	333a	343a	117a	223a
Dn	9s	79.9	73.9	89a	257a	....	280b	276a	283c	149a	274b
En	15s	87.1	80	114c	194c	231a	315a	353a	362a	117a	224a
Gn	18s	89.9	80.5	120c	166c	241a	345a	332a	379a	133a	222a
Bn	10s	74.5	69.8	101b	263b	290a	396a	333b	447a	....	189a

Cement.		Tensile strength (pounds per square inch).									
Brand.	Sample.	1 part sand to 1 cement (by weight).			3 parts sand to 1 cement (by weight).					5 of sand to 1 of cement.	
		6 months.	1 year.	2 years.	28 days.	3 months.	6 months.	1 year.	2 years.	6 months.	2 years.
Cn	14s	469b	467b	394b	139a	....	....	330b	....	....	....
An	13s	537a	476a	478a	109b	304a	342a	281a	270a	189a	186a
Fn	19s	427a	373a 437b	477a	131a	222a	276a	265a 303b	268a	123a	144a
Dn	9s	411b	421b	354c	171a	242b	222b	278b	221b	104a	111a
En	15s	384a	322a 353b	388a	114a	237a	275a	240a 276b	224a	126a	141a
Gn	18s	416a	321a 331b	366a	189a	288a	277a	239a 275b	223a	155b	141b
Bn	10s	377a	373a	379a	84b	154a	85a	90a	130a	....	....

SERIES 16.—*Values of different sands for natural cement mortar.*

Reference.	Sand.			Water (per cent of dry ingredients).	Date made (December, 1891).	Age.	Tensile strength.				Molder.	Tank.	Per cent.	
	Kind.	Fineness.	Parts to 1 of cement (weight).				Mean.	Highest.	Lowest.	Number averaged.			After 6 months.	After 1 year.
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*		
							Lbs.	*Lbs.*	*Lbs.*					
*1	C. Q.	M	3	13.6	4	28 days.	117	130	91	10	N	S	....	......
2	P. P.	M	3	13.8	4	28 days.	93	125	80	9	N	S	....	......
†3	L. S.	M	3	15	4	28 days.	181	195	174	5	N	S	....	......
‡4	L. S.	M	3	16.7	4	28 days.	143	159	132	5	N	S	....	......
§5	S. S.	M	3	18.2	4	28 days.	113	124	90	10	N	S	....	......
6	Std.	20–30	3	12.5	4	28 days.	118	129	107	10	N	S	....	......
7	C. Q.	M	3	15.4	5	6 mos...	344	362	320	5	N	S	....	......
8	P. P.	M	3	13.3	5	6 mos...	297	308	270	5	N	S	....	......
9	L. S.	M	3	16.7	5	6 mos...	467	527	394	5	N	S	....	......
10	S. S.	M	3	18.2	5	6 mos...	316	334	286	5	N	S	....	......
11	Std.	20–30	3	12.5	5	6 mos...	330	346	814	5	N	S	....	......
12	C. Q.	M	3	15.4	5	1 year...	356	378	316	5	N	S	+ 3.5	......
13	P. P.	M	2	13.3	5	1 year...	339	360	324	5	N	S	+14	......
14	L. S.	M	3	16.7	5	1 year...	526	552	486	5	N	S	+12.5	......
15	S. S.	M	3	18.2	5	1 year...	416	440	404	5	N	S	+31.5	......
16	Std.	20–30	3	12.5	5	1 year...	342	378	320	5	N	S	+ 3.5	......
17	C. Q.	M	3	15.4	7	2 years..	332	347	319	10	N	S	— 3.5	— 7
18	P. P.	M	3	13.3	7	2 years..	308	321	298	10	N	S	— 3.5	— 9
19	L. S.	M	3	16.7	7	2 years..	601	649	535	10	N	S	+29	+14
20	S. S.	M	3	18.2	7	2 years..	462	520	434	9	N	S	+46	+11
21	Std.	20–30	3	12.5	7	2 years..	324	350	280	10	N	S	— 2	— 5

* Trifle dry—1 briquet below 100 pounds. † Trifle dry. ‡ Mortar plastic.
§ 1 briquet below 100 pounds.

NOTE.—C. Q. means crushed quartz. P. P. means from Point aux Pins. L. S. means limestone screenings. S. S. means sandstone screenings. Std. means standard sand.

Fineness.—Expression 20–30 means passing No. 20 sieve and failing to pass No. 30, etc. M means 25 per cent each of 20–30, 30–40, 40–50, and 50–80.

SERIES 17.—*Values of different sands for use in Portland cement mortar.*

Reference.	Sand.			Water (per cent of dry ingredients).	Date made (1891).	Age.	Tensile strength.				Molder.	Tank.	Remarks.
	Kind.	Fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	
							Lbs.	*Lbs.*	*Lbs.*				
1	C. Q.	M	3	11.1	11, 30	28 days	291	314	282	5	N	R	Rather dry.
2	C. Q.	M	3	12.5	11, 30	28 days	255	266	240	5	N	R	
3	P. P.	M	3	12.5	11, 30	28 days	186	196	179	5	N	R	Rather moist.
4	P. P.	M	3	11.1	11, 30	28 days	206	219	192	5	N	R	
5	L. S.	M	3	12.5	11, 30	28 days	407	420	394	10	N	R	Trifle dry, plastic.
6	S. S.	M	3	12.5	11, 30	28 days	321	354	289	10	N	R	Do.
7	Std.	20-30	3	11.1	11, 30	28 days	259	274	227	10	N	R	
8	C. Q.	M	3	12.5	12, 1	6 mos	327	350	301	5	N	K and C	
9	P. P.	M	3	11.1	12, 1	6 mos	284	303	266	5	N	K and C	Trifle more moist than 8.
10	L. S.	M	3	12.5	12, 1	6 mos	574	591	559	5	N	K and C	Trifle dry, plastic.
11	S. S.	M	3	12.5	12, 1	6 mos	438	470	396	5	N	K and C	Do.
12	Std.	20-30	3	11.1	12, 1	6 mos	344	355	332	5	N	K and C	
13	C. Q.	M	3	12.5	12, 1	1 year	359	396	332	5	N	K and C	
14	P. P.	M	3	12.5	12, 1	1 year	329	344	298	5	N	K and C	Trifle more moist than 13.
15	L. S.	M	3	11.1	12, 1	1 year	667	706	636	5	N	K and C	Trifle dry, plastic.
16	S. S.	M	3	12.5	12, 1	1 year	495	562	446	5	N	K and C	Do.
17	Std.	20-30	3	11.1	12, 1	1 year	369	388	354	5	N	K and C	
18	C. Q.	M	3	12.5	12, 2	2 years	335	366	292	10	N	K and T	
19	P. P.	M	3	11.1	12, 2	2 years	324	352	298	10	N	K and T	
20	L. S.	M	3	13.3	12, 2	2 years	665	714	604	10	N	K and T	3 briquets slipped in clips.
21	S. S.	M	3	14.3	12, 2	2 years	492	552	445	10	N	K and T	
22	Std.	20-30	3	11.1	12, 2	2 years	335	352	304	10	N	K and T	

NOTE.—C. Q. means crushed quartz. P. P. means from Point aux Pins. L. S. means limestone screenings. S. S. means sandstone screenings. Std. means standard sand.

Fineness—Expression 20-30 means passing No. 20 sieve and failing to pass No. 30 sieve, etc. M means 25 per cent each of 20-30, 30-40, 40-50, and 50-80.

Series 18.—*Varying fineness of Point aux Pins sand; effect on value of, in use with natural cement.*

Reference.	Sand.			Water (per cent of dry ingredients).	Date made (April, 1892).	Age.	Tensile strength.				Molder.	Tank.
	Kind.	Fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*
							Lbs.	*Lbs.*	*Lbs.*			
1	P. P.	$m^{10}f^{0}v^{0}$	3	12.5	4	28 days .	77	86	68	5	N	I
2	P. P.	$m^{4}f^{1}v^{5}$	3	13.4	4	28 days .	77	88	66	5	N	I
3	P. P.	$m^{2}f^{4}v^{4}$	3	13.4	4	28 days .	79	95	67	5	N	I
4	P. P.	$m^{1}f^{3}v^{6}$	3	14.3	4	28 days .	46	50	41	5	N	I
5	P. P.	$m^{1}f^{2}v^{7}$	3	14.8	4	28 days .	67	70	64	5	N	I
6	P. P.	$m^{10}f^{0}v^{0}$	3	12.5	4	6 mos...	267	277	253	5	N	I
7	P. P.	$m^{4}f^{1}v^{5}$	3	13.4	4	6 mos...	237	255	211	5	N	I
8	P. P.	$m^{2}f^{4}v^{4}$	3	13.4	4	6 mos...	278	298	269	5	N	I
9	P. P.	$m^{1}f^{3}v^{6}$	3	14.3	4	6 mos...	222	230	217	5	N	I
10	P. P.	$m^{1}f^{2}v^{7}$	3	14.8	4	6 mos...	226	238	213	5	N	I
11	P. P.	$m^{10}f^{0}v^{0}$	3	12.5	7	1 year ..	348	356	326	5	N	I
12	P. P.	$m^{4}f^{1}v^{5}$	3	13.4	7	1 year ..	304	325	271	5	N	I
13	P. P.	$m^{2}f^{4}v^{4}$	3	13.4	7	1 year ..	291	312	257	5	N	I
14	P. P.	$m^{1}f^{3}v^{6}$	3	14.3	7	1 year ..	234	256	216	5	N	I
15	P. P.	$m^{1}f^{2}v^{7}$	3	14.8	7	1 year ..	247	261	236	5	N	I
16	P. P.	$m^{10}f^{0}v^{0}$	3	12.5	7	2 years.	341	346	336	5	N	I
17	P. P.	$m^{4}f^{1}v^{5}$	3	13.4	7	2 years.	319	339	305	5	N	I
18	P. P.	$m^{2}f^{4}v^{4}$	3	13.4	7	2 years.	325	339	313	5	N	I
19	P. P.	$m^{1}f^{3}v^{6}$	3	14.3	7	2 years.	251	293	235	5	N	I
20	P. P.	$m^{1}f^{2}v^{7}$	3	14.8	7	2 years.	251	294	224	5	N	I

NOTE.—Fineness of sand is indicated by letters m, f, v; m passes 20 sieve, is caught on 30; f passes 30 sieve, is caught on 40; v passes 40. Exponents show number of parts of each used. Sand from Point aux Pins.

Series 18a.—*Varying fineness of Point aux Pins sand; effect on value of, in use with natural cement.*

Reference.	Sand.		Water (per cent of dry ingredients).	Date made (January, 1893.)	Age.	Tensile strength.				Molder.	Tank.
	Fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
						Lbs.	*Lbs.*	*Lbs.*			
1	$c^{5}m^{20}f^{45}v^{30}$........	2	14.8	23	6 mos .	372	456	345	10	N	U
2	$c^{5}m^{20}f^{40}v^{35}$........	2	14.8	23	6 mos .	362	387	349	10	N	U
3	$c^{5}m^{15}f^{35}v^{45}$........	2	15.3	23	6 mos .	376	427	327	10	N	U
4	$c^{5}m^{15}f^{20}v^{60}$........	2	15.6	23	6 mos .	383	415	340	10	N	U
5	$c^{5}m^{10}f^{25}v^{60}$........	2	15.8	23	6 mos .	343	370	302	10	N	U

NOTE.—c passes 10 sieve (holes 0.08 inch square), retained on 20 (0.033 inch square); m passes 20 sieve, is retained on 30 (holes 0.022 inch square); f passes 30 sieve, is retained on 40 (holes 0.017 inch square); v passes 40 sieve (holes 0.017 inch square). Exponents show number of parts or per cent of each used.

SERIES 19.—*Varying fineness of Point aux Pins sand; effect on value of, in use with Portland cement.*

Reference.	Sand.			Water (per cent of dry ingredients).	Date made (April, 1892).	Age.	Tensile strength.				Molder.	Tank.
	Kind.	Fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.		
	a	b	c	d	e	f	g	h	i	j	k	l
							Lbs.	*Lbs.*	*Lbs.*			
*1	P. P.	$m^{10}f^0v^0$	2	11.1	2	28 days.	342	360	330	5	N	C
2	P. P.	$m^4f^1v^5$	2	11.7	2	28 days.	300	343	274	5	N	C
3	P. P.	$m^2f^4v^4$	2	11.7	2	28 days.	290	308	264	5	N	C
4	P. P.	$m^1f^3v^6$	2	12.3	2	28 days.	246	268	234	5	N	C
5	P. P.	$m^1f^2v^7$	2	13	2	28 days.	271	281	263	5	N	C
*6	P. P.	$m^{10}f^0v^0$	2	11.1	2	6 mos...	471	500	452	5	N	C
7	P. P.	$m^4f^1v^5$	2	11.7	2	6 mos...	448	454	440	5	N	C
8	F. P.	$m^2f^4v^4$	2	11.7	2	6 mos...	425	450	370	5	N	C
9	P. P.	$m^1f^3v^6$	2	12.3	2	6 mos...	384	405	350	5	N	C
10	P. P.	$m^1f^2v^7$	2	13	2	6 mos...	366	375	346	5	N	C
11	P. P.	$m^{10}f^0v^0$	2	10.5	6	1 year...	560	585	521	5	N	C
12	P. P.	$m^4f^1v^5$	2	11.7	6	1 year...	515	542	484	5	N	C
13	P. P.	$m^2f^4v^4$	2	11.7	6	1 year...	494	522	468	5	N	C
14	P. P.	$m^1f^3v^6$	2	12.3	6	1 year...	455	480	417	5	N	C
15	P. P.	$m^1f^2v^7$	2	13	6	1 year...	456	468	426	5	N	C
16	P. P.	$m^{10}f^0v^0$	2	10.5	6	2 years..	591	617	541	5	N	C
17	P. P.	$m^4f^1v^5$	2	11.7	6	2 years..	507	534	474	5	N	C
18	P. P.	$m^2f^4v^4$	2	11.7	6	2 years..	503	520	484	5	N	C
19	P. P.	$m^1f^3v^6$	2	12.3	6	2 years..	442	466	406	5	N	C
20	P. P.	$m^1f^2v^7$	2	13	6	2 years..	438	462	415	5	N	C

* Trifle moist.

See note appended to Series 18.

SERIES 19a.—*Varying fineness of Point aux Pins sand; effect on value of in use with Portland cement.*

Reference.	Sand.		Water (per cent of dry ingredients).	Date made (January, 1893).	Age.	Tensile strength.				Molder.	Tank.
	Fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.		
	a	b	c	d	e	f	g	h	i	j	k
						Lbs.	*Lbs.*	*Lbs.*			
1	$c^5m^{20}f^{45}v^{30}$........	2....	11.8	26	6 mos...	566	622	515	10	N	C
2	$c^5m^{20}f^{40}v^{35}$........	2....	12	26	6 mos...	544	581	512	10	N	C
3	$c^5m^{15}f^{35}v^{45}$........	2....	12.2	26	6 mos...	551	584	523	10	N	C
4	$c^5m^{15}f^{30}v^{50}$........	2....	12.4	26	6 mos...	528	560	495	10	N	C
5	$c^5m^{10}f^{25}v^{60}$........	......	12.7	26	6 mos...	540	608	480	10	N	C

See note appended to Series 18a.

SERIES 20.—*Limestone screenings; effect of varying fineness on its value for use with Portland cement.*

Reference.	Sand.			Water (per cent of dry ingredients).	Date made (1892).	Age.	Tensile strength.				Molder.	Tank.	Weight of 10 briquets dried by wiping just before breaking.	Remarks.
	Kind.	Fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.				
	a	b	c	d	e	f	g	h	i	j	k	l	m	
							Lbs.	Lbs.	Lbs.				Grams.	
1	L. S.	10-20	3	10.7	3, 31	6 mos.	716	757	685	5	N	C	1, 534	Trifle dry.
2	....	10-20	3	11.1	3, 31	6 mos.	721	827	645	5	N	C		Still trifle dry.
3	....	20-30	3	12.5	3, 31	6 mos.	657	725	600	10	N	C	1, 521	Trifle dry, same as No. 1.
4	....	30-40	3	13.3	3, 31	6 mos.	633	662	598	10	N	C	1, 500	Do.
5	....	40-50	3	14.8	3, 31	6 mos.	516	584	484	10	N	C	1, 466	Do.
6	....	Pass 50	3	17.9	3, 31	6 mos.	403	450	355	10	N	C	1, 407	Trifle dry. Shrank away from molds.
7	....	10-20	3	12.5	4, 1	2 yrs..	812	860	775	6	N	C	....	
8	....	20-30	3	14.1	4, 1	2 yrs..	754	808	679	5	N	C	....	
9	....	30-40	3	15	4, 1	2 yrs..	656	689	615	5	N	C	....	
10	....	40-80	3	17.2 16.7	4, 1	2 yrs..	516	538	492	5	N	C	....	3 trifle moist, 2 OK.
11	....	Pass 50	3	19.6 19.3	4, 1	2 yrs..	488	496	476	5	N	C	....	Do.

SERIES 21.—*Portland and natural cements with Point aux Pins sand.*

TABLE 1*a*.—STRENGTH OF PORTLAND MORTARS—TWO YEARS.

Reference.	Cement.			Parts sand to 1 of cement (by weight).	Water (per cent of dry ingredients).	Day made (January, 1892).	Tensile strength.				Molder.	Tank.	Comparison with six months, results.
	Brand.	Sample.	Fineness (per cent pass holes 0.0065 inch square).				Mean.	Highest.	Lowest.	Number averaged.			
	a	b	c	d	e	f	g	h	i	j	k	l	m
							Lbs.	Lbs.	Lbs.				
1	H	21s	93	2	10.3	8	534	550	526	5	N	T and C	+22
2	R	300s	91	2	10.3	8	548	554	540	5	N	T and C	+44
3	G	1	91	2	10.3	8	481	507	446	5	N	T and C	+43
4	A	20s	88	2	10.3	8	451	470	425	5	N	T and C	+19
5	I	8s	93	2	10.3	8	517	536	502	5	N	T and C	+97
6	H	21s	93	3	11.5	9	363	393	340	5	N	g and C	—27
7	R	300s	91	3	11.5	9	355	371	341	5	N	g and C	+20
8	H	21s	93	4.09	10.7	9	296	303	284	5	N	g and C	+ 1
9	R	300s	91	4.09	10.7	9	288	308	274	5	N	g and C	+27
10	A	20s	88	4.09	10.7	9	260	275	245	5	N	g and C	+32
11	R	300s	91	5	11.8	11	199	220	180	5	N	K and T	+55
12	A	20s	88	5	11.8	11	167	180	146	5	N	K and T	+ 8
13	H	21s	93	6	12.2	11	191	200	186	5	N	K and C	+16
14	R	300s	91	6	12.2	11	174	180	168	5	N	K and C	+30
15	I	8s	93	6	12.2	11	151	172	110	5	N	K and T	+17
16	H	21s	93	8	12.1	13	132	143	126	5	N	i and C	+19
17	R	300s	91	8	12.1	13	132	145	126	5	N	i and C	+36
18	G	1	91	8	12.1	13	115	131	102	5	N	i and C	+19
19	A	20s	88	8	12.1	13	123	133	107	5	N	i and C	+15
20	I	8s	93	8	12.1	13	103	120	86	4	N	i and C	+14
21	H	21s	93	10	12.1	14	104	122	93	5	N	c and C	+40
22	R	300s	91	10	12.1	14	116	139	103	5	N	c and C	+42
23	G	1	91	10	12.1	14	102	114	90	5	N	g and C	+36
24	A	20s	88	10	12.1	14	100	111	88	5	N	g and C	+42
25	I	8s	93	10	12.1	14	104	121	99	5	N	f and C	+44

SERIES 21.—*Portland and natural cements with Point aux Pins sand*—Continued.

TABLE 2*a*.—STRENGTH OF NATURAL CEMENT MORTARS—TWO YEARS.

Reference.	Cement.			Parts sand to 1 of cement (by weight).	Water (per cent of dry ingredients).	Day made (January, 1892).	Tensile strength.				Molder.	Tank.	Comparison with six months, results.
	Brand.	Sample.	Fineness (per cent pass holes 0.0065 inch square).				Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*
							Lbs.	*Lbs.*	*Lbs.*				
1	Gn	18s	89	1	17.6	4	280	310	254	10	N	S	—28
2	En	15s	89	1	16.2	4	279	308	252	10	N	S	—11
3	Fn	19s	89	1	16.2	4	348	383	316	10	N	S	— 2
4	Bn	10s	75	1	18.75	4	322	344	305	10	N	S	—15
5	An	13s	86	1	17.6	4	349	367	297	10	N	S	—32
6	Gn	18s	89	2	13.3	5	324	352	282	5	N	N	+10
7	En	15s	89	2	12.1	5	338	355	330	5	N	N	+70
8	Fn	19s	89	2	12.1	5	334	371	311	5	N	N	— 5
9	Cn	14s	86	2	13.3	5	333	346	308	5	N	N	+29
10	Gn	18s	89	3	12.5	5	294	312	272	5	N	N	+14
11	Gn	18s	89	4	12	6	187	201	174	5	N	L and I	— 6
12	Fn	19s	89	4	12	6	184	201	177	5	N	L and I	+60
13	Dn	9s	79	4	12	6	228	236	217	5	N	L and I	+27
14	An	13s	86	4	12	6	188	204	176	5	N	L and I	+ 7
15	Gn	18s	89	5	11.1	6	165	173	155	5	N	L and I	+ 4
16	Gn	18s	89	6	11.4	7	172	191	147	5	N	L and I	+30
17	En	15s	89	6	11.4	7	105	117	98	5	N	L and I	+31
18	Dn	9s	79	6	11.4	7	152	162	136	5	N	L and I	+21
19	Gn	18s	89	7	11.5	7	156	166	147	5	N	L and I	+37
20	Gn	18s	89	8	12.1	7	114	125	101	5	N	L and I	+13

TABLE 3*a*.—INGREDIENTS REQUIRED FOR 1 CUBIC YARD OF MORTAR AND COST IN DETAIL.

Sand (parts by weight to 1 of cement).	Portland.					Natural.				
	Cement.		Sand.		Total cost of mortar per cubic yard.	Cement.		Sand.		Total cost of mortar per cubic yard.
	Barrels.	Cost.	Cubic yards.	Cost.		Barrels.	Cost.	Cubic yards.	Cost.	
a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
0	7.30	$21.90	....	....	$21.90	*7.95	$10.33	....	....	*$10.33
1	4.05	12.15	.57	$0.57	12.72	4.95	6.43	.51	$0.51	6.94
2	2.80	8.40	.78	.78	9.18	3.45	4.48	.72	.72	5.20
3	2	6.00	.85	.85	6.85	2.55	3.31	.80	.80	4.11
4	1.60	4.80	.89	.89	5.69	2.05	2.66	.84	.84	3.50
5	1.30	3.90	.91	.91	4.81	*1.65	2.15	*.86	.86	*3.01
6	1.10	3.30	.93	.93	4.23	*1.40	1.82	*.88	.88	*2.70

NOTES.

Prices, etc.: Portland, per barrel, 380 pounds net, $3; Natural, per barrel, 280 pounds net, $1.30; P. P. sand, per cubic yard, 2,700 pounds, $1.

Results marked (*) were derived by analogy. Other results derived directly from experiments with the given proportions.

P. P. sand used had fineness approximately as follows:

Sieve	Letter	C	D	E	F	H
	No	20	30	40	50	80
	Size holes	.031 x .034	.021 x .023	.016 x .018	.012 x .013	.007 x .007
Per cent passing		96	82	47	7	1

Voids in sand about three-eighths.

SERIES 25*a*.—*Effect of regauging natural cement mortar.*

[Age of briquets, 1 year. Sample 54R, Gn brand. Nos. 16-25 sand: 2 parts, by weight, of standard sand 20-30; Nos. 1-15, 2 parts, by weight, of P. P. sand passing holes 0.08 inch square.]

Reference.	Water (per cent of dry ingredients).	Date made (1893).	Tensile strength.				Moulder.	Tank.	Total time mortar allowed to stand (hours).	Total number gaugings.	Interval between gaugings (hours and minutes).	Total time gauged (minutes).	Water.		Consistency.
			Mean.	Highest.	Lowest.	Number averaged.							Cubic centimeter added in regauging.	Final per cent.	
	b	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*
			Lbs.	*Lbs.*	*Lbs.*										
1	13.3	2, 27	354	404	318	10	N	Q	....	1	....	2	....	......	Dry; briquets showed some moisture.
2	15.3	2, 27	352	371	323	10	N	Q	....	1	....	2	....	......	O K.
3	17.2	2, 27	333	369	295	10	N	Q	....	1	....	2	....	......	Moist.
4	15.3	2, 27	356	406	315	10	N	Q	....	1	....	4	....	......	O K.
5	15.3	2, 27	482	537	417	10	N	Q	....	1	....	8	....	......	Between 2 and 3.
6	15.3	2, 28	359	385	311	10	N	Q	....	1	....	...	....	......	O K.
7	15.3	2, 28	381	426	341	10	N	Q	1	3	30 m	...	....	......	Trifle dry.
8	15.3	2, 28	336	369	310	10	N	Q	2	2	2 h.	...	....	......	Same as 1.
9	15.3	2, 28	404	435	344	10	N	Q	2	5	30 m	...	....	......	Do.
10	15.3	2, 28	364	419	290	10	N	Q	4	9	30 m	...	....	......	Very dry; briquets showed no moisture.
11	15.3	3, 1	386	419	350	10	N	Q	....	1	....	...	....	......	Same as 2. O K.
12	15.3	3, 1	394	428	374	10	N	Q	1	3	30 m	...	4	15.8	Final, O K.
13	15.3	3, 1	345	387	288	10	N	Q	2	2	2 h.	...	10	16.7	Final, trifle dry.
14	15.3	3, 1	435	479	403	9	N	Q	2	5	30 m	...	10	16.7	Final, O K and more plastic.
15	15.3	3, 1	412	448	373	9	N	Q	4	9	30 m	...	10	18.6	Same as 14.
16	15.9	2, 20	408	441	381	10	N	G	....	1	....	2	....	......	Dry.
17	15.3	2, 20	418	465	383	10	N	G	....	1	....	2	....	......	O K.
18	16.7	2, 20	418	468	385	10	N	G	....	1	....	2	....	......	Trifle moist.
19	15.3	2, 20	459	505	402	10	N	G	....	1	....	4	....	......	O K.
20	15.3	2, 20	572	630	498	10	N	G	....	1	....	8	....	......	Same as 18.
21	15.3	2, 21	455	491	372	10	N	G	....	1	....	...	....	......	O K.
22	15.3	2, 21	*431	463	389	10	N	G	1	2	*60 m	...	....	......	Final, same as 16.
23	15.3	2, 21	†395	425	372	10	N	G	2	2	†2 h.	...	....	......	Final, drier than 22.
24	15.3	2, 21	421	474	357	10	N	G	2	5	30 m	...	....	......	Final, between 22 and 23.
25	15.3	2, 21	350	391	301	9	N	G	4	5	60 m	...	....	......	Final, very dry.

*Would nearly hold one-twelfth-inch wire weighing one-fourth pound before regauging.
†Would hold one-twelfth-inch wire weighing one-fourth pound before regauging.

SERIES 25*b*.—*Effect of regauging natural cement mortar.*

[Age of briquets, 1 year. Sample 13*s*, brand A*n*. Sand: 2 parts by weight of P. P. sand passing holes 0.08 inch square.]

Reference.	Water (per cent of dry ingredients).	Date made (1893).	Tensile strength.				Moulder.	Tank.	Total time mortar allowed to stand (hours).	Total number gaugings.	Interval between gaugings (hours and minutes).	Total time gauged (minutes).	Water.		Consistency.
			Mean.	Highest.	Lowest.	Number averaged.							Cubic centimeter added in regauging.	Final per cent.	
	b	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*
			Lbs.	*Lbs.*	*Lbs.*										
1	13	3, 2	367	460	325	10	N	Q	....	1	....	2	....	....	Dry, but showed some moisture on briquets.
2	15	3, 2	368	438	334	10	N	Q	....	1	....	2	....	....	O K.
3	16.9	3, 2	334	389	291	10	N	Q	....	1	....	2	....	....	Very moist.
4	15	3, 2	376	421	352	10	N	Q	....	1	....	4	....	....	Trifle more moist than 2.
5	15	3, 2	421	470	380	10	N	Q	....	1	....	8	....	....	Same as 3.
6	15.1	3, 3	365	409	320	10	N	Q	....	1	....	....	....	....	Same as 2.
7	15.1	3, 3	390	418	369	10	N	Q	1	3	30 m	....	....	....	When molded was trifle more moist than when gauged.
8	15	3, 3	355	403	316	10	N	Q	2	2	2 h	....	....	....	Same as 1.
9	15.1	3, 3	436	472	401	10	N	Q	2	5	30 m	....	....	....	Do.
10	15.1	3, 3	189	215	160	10	N	Q	4	9	30 m	....	....	....	Very dry; no moisture on briquets.
11	15.1	3, 4	384	430	331	10	N	Q	....	1	....	....	....	....	Same as 2.
12	15.1	3, 4	450	490	406	10	N	Q	1	3	30 m	....	....	....	O K.
13	15.1	3, 4	367	401	326	10	N	Q	2	2	2 h	....	6	15.8	O K.
14	15.1	3, 4	447	483	392	10	N	Q	2	5	30 m	....	6	15.8	Trifle drier than 13.
15	15.1	3, 4	388	452	342	10	N	Q	4	9	30 m	....	38	19.7	Trifle drier than when first gauged, but more plastic.

SERIES 26*a*.—*Effect of regauging Portland cement mortar.*

[Age of briquets, 1 year. Sample 42m, brand R. Sand: 2 parts by weight of P. P. sand passing No. 10 sieve holes 0.08 inch square.]

1	10.9	2, 23	541	589	478	10	N	R	....	1	....	2	....	....	O K.
2	12.1	2, 23	525	570	447	10	N	R	....	1	....	2	....	....	Trifle moist.
3	13.3	2, 23	546	647	504	10	N	R	....	1	....	2	....	....	Quite moist.
4	12.1	2, 23	554	660	478	10	N	R	....	1	....	4	....	....	Same as 2.
5	12.1	2, 23	616	661	553	10	N	R	....	1	....	8	....	....	Same as 3.
6	12.1	2, 24	579	652	506	10	N	R	....	1	....	....	....	....	Same as 2.
7	12.1	2, 24	565	643	522	10	N	R	1	2	1 h	....	....	....	Do.
8	12.1	2, 24	570	615	528	10	N	R	5	6	1 h	....	....	....	Same as 1.
9	12.1	2, 24	568	640	531	10	N	R	5	2	5 h	....	....	....	Trifle dry.
10	12.1	2, 24	569	626	526	10	N	R	3	4	1 h	....	....	....	Between 2 and 3.
11	12.1	2, 25	554	583	512	10	N	R	....	1	....	....	....	....	Same as 2.
12	12.1	2, 25	579	649	515	10	N	R	1	2	1h	....	....	....	Do.
13	12.1	2, 25	624	699	558	10	N	R	5	6	1h	....	12	13.6	Final, trifle dry.
14	12.1	2, 25	560	628	520	10	N	R	5	2	5h	....	10	13.3	O K.
15	12.1	2, 25	627	652	597	10	N	R	3	4	1h	....	4	12.6	O K.

SERIES 27.—*Rate of increase in strength of two samples of same brand of natural cement.*

Reference.	Sample.	Sand (parts to 1 of cement, by weight).	Water (per cent of dry ingredients).	Date made (February, 1892).	Age when broken.	Tensile strength. Mean.	Tensile strength. Highest.	Tensile strength. Lowest.	Number averaged.	Molder.	Tank.	Remarks.
	a	b	c	d	e	f	g	h	i	j	k	
						Lbs.	*Lbs.*	*Lbs.*				
1	12R	0	30.8	23	1 day ...	36	44	26	5	N	P	Immersed 90 minutes after molded.
2	12R	0	30.8	23	2 days ..	32	39	28	5	N	P	
3	12R	0	30.8	23	3 days ..	61	66	52	5	N	P	
4	12R	0	30.8	23	5 days ..	71	77	65	5	N	P	
5	12R	0	30.8	23	7 days ..	106	127	95	5	N	P	
6	12R	0	30.8	23	10 days .	120	135	89	5	N	P	
7	12R	0	30.8	23	14 days .	148	163	114	5	N	P	
8	12R	0	30.8	23	28 days .	180	188	162	5	N	P	
9	12R	0	30.8	23	3 mos ...	213	238	198	5	N	P	
10	12R	0	30.8	23	6 mos ...	207	272	153	5	N	P and I	In tank I 3 months. All briquets cracked.
11	18R	0	30.8	24	1 day ..	37	45	32	5	N	P	Same remark as 1.
12	18R	0	30.8	24	2 days ..	45	49	40	5	N	P	
13	18R	0	30.8	24	3 days ..	86	95	80	5	N	P	
14	18R	0	30.8	24	5 days ..	99	113	93	5	N	P	
15	18R	0	30.8	24	7 days ..	116	134	110	5	N	P	
16	18R	0	30.8	24	10 days .	120	126	110	5	N	P	
17	18R	0	30.8	24	14 days .	151	161	144	5	N	P	
18	18R	0	30.8	24	28 days .	187	210	167	4	N	P	
19	18R	0	30.8	24	3 mos ...	223	262	196	5	N	P	
20	18R	0	30.8	24	6 mos ...	225	230	218	5	N	P	Same remarks as 10.
21	12R	1	17.6	27	28 days .	209	229	193	5	N	N	
22	12R	1	17.6	27	3 mos ...	365	401	298	5	N	N	
23	12R	1	17.6	27	6 mos ...	341	406	261	5	N	N	
24	12R	1	17.0	27	2 years .	350	406	321	5	N	N	
25	18R	1	17.6	27	28 days .	228	240	220	5	N	N	
26	18R	1	17.6	27	8 mos ...	356	389	312	5	N	N	
27	18R	1	17.6	27	6 mos ...	324	360	300	5	N	N	
28	18R	1	17.6	27	2 years .	298	340	258	5	N	N	

Sample.	Per cent passing holes 0.0065 inch square.	Time to bear $\frac{1}{12}$" wire weighing ¼ pound.
		Minutes.
12R	91.6	36
18R	89.5	*58

* Mortar trifle more moist than 12R.

SERIES 28.—*Rate of increase in strength of a sample of natural cement in warm and cool water.*

[Sample 18R, brand Gn.]

Reference.	Sand (parts to 1 of cement).	Water (per cent of dry ingredients).	Date made (February, 1892).	Age (days).	Tensile strength.				Molder.	Time in moist air (hours).	Time in vapor (hours).	Where stored.*
					Mean.	Highest.	Lowest.	Number averaged.				
	a	b	c	d	e	f	g	h	i	j	k	l
					Lbs.	*Lbs.*	*Lbs.*					
1	0	30.8	2	2	92	107	82	5	N	24	......	Steamer.
2	0	30.8	2	4	133	146	115	5	N	24	......	Do.
3	0	30.8	2	7	205	225	185	5	N	24	......	Do.
4	0	30.8	2	10	176	191	158	5	N	24	......	Do.
5	0	30.8	2	4	81	89	77	5	N	24	......	Tank B.
6	0	30.8	2	7	107	116	98	5	N	24	......	Do.
7	0	30.8	2	14	133	150	120	5	N	24	......	Do.
8	0	80.8	2	28	157	176	142	8	N	24	......	Do.
9	1	18.75	3	2	76	88	72	5	N	24	......	Steamer.
10	1	18.75	3	4	108	117	102	5	N	24	......	Do.
11	1	18.75	3	7	178	184	174	5	N	24	......	Do.
12	1	18.75	3	10	216	222	205	5	N	24	......	Do.
13	1	18.75	3	2	78	86	73	5	N	3	3	Do.
14	1	18.75	3	4	147	160	134	5	N	8	3	Do.
15	1	18.75	3	4	89	99	79	5	N	24	......	Tank B.
16	1	18.75	3	7	115	116	112	5	N	24	......	Do.
17	1	18.75	3	14	146	156	131	5	N	24	......	Do.
18	1	18.75	3	28	215	231	193	5	N	24	......	Do.

* Temperature of water in steamer, about 100° F.; temperature of tank, about 60° F.

SERIES 29.—*Rate of increase in strength of a sample of Portland cement in warm and cool water.*

[Sample 21P, brand R.]

Reference.	Sand (parts to 1 of cement).	Water (per cent of dry ingredients).	Date made (February, 1892).	Age (days).	Tensile strength.				Molder.	Time in moist air (hours).	Time in vapor (hours).	Where stored.*
					Mean.	Highest.	Lowest.	Number averaged.				
	a	b	c	d	e	f	g	h	i	j	k	l
					Lbs.	*Lbs.*	*Lbs.*					
1	0	20	4	4	489	520	470	5	N	24	......	Tank T.
2	0	20	4	7	530	555	531	5	N	24	......	Do.
3	0	20	4	14	592	635	533	5	N	24	......	Do.
4	0	20	4	28	645	652	625	5	N	24	......	Do.
5	3	11.1	5	4	159	162	153	5	N	24	......	Tank C.
6	3	11.1	5	7	197	217	176	5	N	24	......	Do.
7	3	11.1	5	14	232	247	211	5	N	24	......	Do.
8	3	11.1	5	28	234	240	227	5	N	24	......	Do.
9	0	20	4	2	390	433	348	5	N	9½	3	Steamer.
10	0	20	4	4	476	497	462	5	N	9½	3	Do.
11	0	20	4	2	390	412	380	5	N	24	......	Do.
12	0	20	4	4	414	478	378	5	N	24	......	Do.
13	0	20	4	7	515	543	481	5	N	24	......	Do.
14	0	20	4	10	577	621	534	5	N	24	......	Do.
15	3	11.1	5	2	142	148	135	5	N	21	3	Do.
16	3	11.1	5	4	172	187	151	5	N	21	3	Do.
17	3	11.1	5	2	132	142	129	5	N	24	......	Do.
18	3	11.1	5	4	173	185	158	5	N	24	......	Do.
19	3	11.1	5	7	202	218	182	5	N	24	......	Do.
20	3	11.1	5	10	209	218	193	5	N	24	......	Do.

* Temperature of Tank T, about 60° F. Temperature of Tank C, about 65° F. Temperature of steamer about 100° F.

SERIES 31.—*Effect of regauging Portland cement mortar.*

Reference.	Age of briquets.	Tensile strength.				Remarks.
		Mean.	Highest.	Lowest.	Number averaged.	
	a	b	c	d	e	
		Lbs.	*Lbs.*	*Lbs.*		
1	3 mos...	559	574	547	5	Treated as usual (mortar molded when gauged).
2	3 mos...	525	540	512	5	Mortar let stand 1 hour, regauged and briquets made. Consistency of mortar did not appear to change.
3	3 mos...	556	586	506	5	Mortar let stand 3 hours, regauged and briquets made. In regauging, 10 c. c. water (or 10 per cent of amount first used) added to make mortar same consistency as at first.
4	3 mos...	537	576	520	5	Mortar let stand 3 hours, regauged every hour. 10 c. c. water added at last regauging.
5	3 mos...	599	656	542	5	Mortar let stand 5 hours, regauged every hour. 33 c. c. water (33 per cent of amount first used) added at last regauging.
6	1 year ..	605	625	584	5	See 1.
7	1 year ..	581	600	569	5	See 2.
8	1 year ..	559	575	535	5	See 3.
9	1 year ..	576	603	537	5	See 4.
10	1 year ..	612	632	587	5	See 5.

NOTE.—Proportions: 275 grs. cement, sample 5a, brand H; 550 grs. sand passing No. 10 sieve; 100 c. c. water = 12.1 per cent of dry ingredients. No. 10 sieve has holes 0.08 of an inch square. All briquets made by molder N 5, 21, 1892, and immersed in same Tank R. Sand from Point aux Pins. Cement when mixed neat with 20 per cent water begins to set after 40 to 60 minutes in temperature of 65° F.

SERIES 33.—*Results obtained by different molders when using similar mortar.*

[Cement, brand Gn, sample 21R. Sand, crushed quartz 20-40.]

Reference.	Sand (parts to 1 of cement).	Water 63° to 66° F. (per cent of dry ingredients.)	Temperature of air where gauged.	Tank.	Date made (October, 1891).	Age.	Mean tensile strength.				Number averaged for each molder.
							Molder N.	Molder M.	Molder S.	Molder T.	
	a	b	c	d	e	f	g	h	i	j	k
							Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	
1	0	31.6	62-65	G	* 22	7 days ..	81	92	....	89	5
2	0	31.6	62-65	G	22	28 days.	197	213	....	220	5
3	1	18.7	67-62	G	22	7 days ..	79	91	....	89	5
4	1	18.7	67-62	G	22	28 days .	235	257	....	259	5
5	1	18.7	63-68	G	22	3 mos...	515	541	....	519	5
6	1	18.7	63-68	G	22	1 year ..	558	569	....	555	5
7	2	15.2	70-65	G	22	28 days .	196	186	....	197	5
8	2	15.2	70-65	G	22	3 mos...	423	383	....	406	5
9	3	13.3	65-61	G	22	3 mos...	253	263	....	239	5
10	3	13.3	65-61	G	22	1 year ..	260	232	....	236	5
11	Sum of means						2,797	2,827	....	2,809	5
12	0	31.6	62-65	U 8 hrs, then G.	† 28	7 days ..	....	....	60	60	5
13	0	31.6	62-65	U 8 hrs, then G.	28	28 days .	....	....	145	167	5
14	1	18.7	65	U 6 hrs, then G.	28	7 days ..	....	....	67	71	5
15	1	18.7	65	U 6 hrs, then G.	28	28 days .	....	....	223	211	5
16	1	18.7	65	U 5 hrs, then G.	28	3 mos...	....	....	435	449	5
17	1	18.7	65	U 5 hrs, then G.	28	1 year ..	....	....	504	491	5
18	2	15.2	67	U 2 hrs, then G.	28	28 days .	....	....	183	‡ 179	5
19	Sum of means								1,616	1,628	

* Clear. † Cloudy. ‡ Mean of 10.

SERIES 33*b*.—*Variations in consistency of mortar.*

TABLE 1.—NEAT NATURAL CEMENT MORTAR.

[Sample 21R, brand Gn.]

Reference.	Water (per cent of dry ingredients).	Date made.	Age.	Tensile strength.				Molder.	Tank.	Remarks.
				Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	
		1892.		*Lbs.*	*Lbs.*	*Lbs.*				
1	28	10, 31	1 day ...	77	86	69	2	S	U	Very dry and hard to gauge.
2	30	10, 31	1 day ...	63	66	60	2	S	U	Dry.
3	32	10, 31	1 day ...	58	64	53	2	S	U	Consistency about right.
4	36	10, 31	1 day ...	38	53	24	2	S	U	Moist.
5	40	10, 31	1 day ...	29	30	29	2	S	U	Very moist.
6	28	10, 31	7 days ..	81	86	76	4	S	U	Same as 1.
7	30	10, 31	7 days ..	74	110	58	4	S	U	Same as 2.
8	32	10, 31	7 days ..	46	57	41	4	S	U	Same as 3.
9	36	10, 31	7 days ..	34	40	27	4	S	U	Same as 4.
10	40	10, 31	7 days ..	42	45	34	4	S	U	Same as 5.
11	28	10, 31	28 days .	182	198	166	2	S	U	Same as 1.
12	30	10, 31	28 days .	138	142	134	2	S	U	Same as 2.
13	32	10, 31	28 days .	116	117	116	2	S	U	Same as 3.
14	36	10, 31	28 days .	80	90	71	2	S	U	Same as 4.
15	40	10, 31	28 days .	75	76	74	2	S	U	Same as 5.
16	28	10, 31	3 mos...	171	181	162	2	T	U	Same as 1.
17	30	10, 31	3 mos...	160	181	140	2	T	U	Same as 2.
18	32	10, 31	3 mos...	144	156	133	2	T	U	Same as 3.
19	36	10, 31	3 mos...	132	154	110	2	T	U	Same as 4.
20	40	10, 31	3 mos...	137	190	84	2	T	U	Same as 5.

NOTE.—The 1-day briquets were immersed 1½ hours after molded.

TABLE 2.—NATURAL CEMENT WITH ONE PART "STANDARD" SAND.

[Cement sample 21R, brand Gn.]

1	10	11, 4	7 days ..	29	34	23	4	S	U	Barely damp; no perceptible cohesion at first.
2	14	11, 4	7 days ..	67	82	51	4	S	U	No moisture on surface of briquets when finished.
3	18	11, 4	7 days ..	76	78	74	4	S	U	About proper consistency.
4	22	11, 4	7 days ..	38	44	32	4	S	U	Too moist to compact except by pressure on top with trowel.
5	26	11, 4	7 days ..	19	26	9	4	S	U	Extremely moist; molds filled at one operation and smoothed off without pressure.
6	10	11, 4	28 days .	63	72	52	4	S	U	Same as 1.
7	14	11, 4	28 days .	115	142	82	4	S	U	Same as 2.
8	18	11, 4	28 days .	167	194	148	4	S	U	Same as 3.
9	22	11, 4	28 days .	125	140	119	4	S	U	Same as 4.
10	26	11, 4	28 days .	77	82	66	4	S	U	Same as 5.
11	10	11, 4	3 mos...	173	180	166	4	S	U	Same as 1.
12	14	11, 4	3 mos...	227	238	217	4	S	U	Same as 2.
13	18	11, 4	3 mos...	378	391	365	4	S	U	Same as 3.
14	22	11, 4	3 mos...	386	391	381	4	S	U	Same as 4.
15	26	11, 4	3 mos...	270	292	249	4	S	U	Same as 5.
16	14	11, 5	7 days ..	49	66	26	4	S	U	Same as 2.
17	16	11, 5	7 days ..	74	83	68	4	S	U	Dry; little moisture on surface briquets.
18	18	11, 5	7 days ..	66	74	62	4	S	U	Same as 3.
19	22	11, 5	7 days ..	38	44	33	4	S	U	Same as 4.
20	26	11, 5	7 days ..	25	28	21	4	S	U	Same as 5.
21	14	11, 5	28 days .	90	106	84	4	S	U	Same as 2.
22	16	11, 5	28 days .	145	160	130	4	S	U	Same as 17.
23	18	11, 5	28 days .	173	184	162	4	S	U	Same as 3.
24	22	11, 5	28 days .	133	136	131	4	S	U	Same as 4.
25	26	11, 5	28 days .	76	86	66	4	S	U	Same as 5.
26	14	11, 5	3 mos...	193	199	188	4	S	U	Same as 2.
27	16	11, 5	3 mos...	312	331	293	4	S	U	Same as 17.
28	18	11, 5	3 mos...	380	390	371	4	S	U	Same as 3.
29	22	11, 5	3 mos...	322	345	299	4	S	U	Same as 4.
30	26	11, 5	3 mos...	286	298	275	4	S	U	Same as 5.
31	14	11, 5	6 mos...	234	280	188	4	S	U	Same as 2.
32	16	11, 5	6 mos...	374	390	350	4	S	U	Same as 17.
33	18	11, 5	6 mos...	416	420	412	4	S	U	Same as 3.
34	22	11, 5	6 mos...	438	449	428	4	S	U	Same as 4.
35	26	11, 5	6 mos...	429	460	399	4	S	U	Same as 5.

SERIES 33*b*.—*Variations in consistency of mortar*—Continued.

TABLE 3.—NEAT NATURAL CEMENT MORTAR.

[Sample 16R, brand Gn.]

Reference.	Water (per cent of dry ingredients).	Date made.	Age.	Tensile strength.				Molder.	Tank.	Remarks.
				Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	
		1893.		*Lbs.*	*Lbs.*	*Lbs.*				
1	28	3, 3	1 day...	68	78	48	10	S	I	Very dry; slight moisture on surface briquets.
2	30	3, 3	1 day...	81	89	71	10	S	I	Dry, but showed moisture on surface briquets.
3	32	3, 3	1 day...	63	70	54	10	S	I	About proper consistency.
4	36	3, 3	1 day...	33	37	30	10	S	I	Trifle moist.
5	40	3, 3	1 day...	17	29	7	8	S	I	Moist, but would hold its shape readily.
6	28	3, 2	7 days..	88	108	68	10	S	I	Same as 1.
7	30	3, 2	7 days..	84	98	96	10	S	I	Same as 2.
8	32	3, 2	7 days..	67	74	58	10	S	I	Same as 3.
9	36	3, 2	7 days..	36	51	28	10	S	I	Same as 4.
10	40	3, 2	7 days..	26	30	24	9	S	I	Same as 5.
11	28	3, 4	28 days.	100	120	90	10	S	I	Same as 1.
12	30	3, 4	28 days.	86	102	76	10	S	I	Same as 2.
13	32	3, 4	28 days.	89	124	76	10	S	I	Same as 3.
14	36	3, 4	28 days.	78	97	65	10	S	I	Same as 4.
15	40	3, 4	28 days.	86	99	76	10	S	I	Same as 5.

TABLE 4.—NATURAL CEMENT WITH TWO PARTS, BY WEIGHT, OF "STANDARD" SAND.

[Cement sample 16R., brand Gn.]

1	11.1	3, 27	28 days .	100	110	91	5	S	I	Very dry; no moisture on surface briquets.
2	13.3	3, 27	28 days .	154	184	130	5	S	I	Rather dry, some moisture on surface briquets.
3	15.3	3, 27	28 days .	120	124	116	5	S	I	About proper consistency.
4	18	3, 27	28 days .	89	91	86	5	S	I	Moist; water oozed from under mold.
5	20.8	3, 27	28 days .	63	70	58	5	S	I	Very moist, but would hold shape.
6	11.1	3, 27, 28	6 mos ...	230	284	176	10	S	I	Same as 1.
7	13.3	3, 27, 28	6 mos ...	316	345	283	10	S	I	Same as 2.
8	15.3	3, 27, 28	6 mos ...	363	400	325	10	S	I	Same as 3.
9	18	3, 27, 28	6 mos ...	351	388	323	10	S	I	Same as 4.
10	20.8	3, 27, 28	6 mos ...	283	294	271	9	S	I	Same as 5.
11	11.1	3, 28, 29	1 year...	234	273	207	10	S	I	Same as 1.
12	13.3	3, 28, 29	1 year...	347	369	326	10	S	I	Same as 2.
13	15.3	3, 28, 29	1 year...	366	422	318	10	S	I	Same as 3.
14	18	3, 28, 29	1 year...	354	378	334	10	S	I	Same as 4.
15	20.8	3, 28, 29	1 year...	308	324	282	10	S	I	Same as 5.

SERIES 33*b*.—*Variations in consistency of mortar*—Continued.

TABLE 5.—NATURAL CEMENT WITH ONE PART "STANDARD" SAND.

[Cement sample 15R, brand Gn.]

Reference.	Water (per cent of dry ingredients).	Date made.	Age.	Tensile strength. Mean.	Tensile strength. Highest.	Tensile strength. Lowest.	Tensile strength. Number averaged.	Molder.	Tank.	Remarks.
	a	b	c	d	e	f	g	h	i	
		1893.		Lbs.	Lbs.	Lbs.				
1	14	2, 27	7 days ..	96	108	90	5	S	I	Very dry; no moisture on surface briquets.
2	16	2, 27	7 days ..	137	162	120	5	S	I	Dry; slight moisture on surface briquets.
3	18	2, 27	7 days ..	130	135	122	5	S	I	Trifle dry.
4	20	2, 27	7 days ..	101	106	93	5	S	I	Trifle moist.
5	22	2, 27	7 days ..	76	80	72	5	S	I	Very moist.
6	14	2, 27	28 days .	124	150	110	5	S	I	Same consistency as 1.
7	16	2, 27	28 days .	214	228	198	5	S	I	Same consistency as 2.
8	18	2, 27	28 days .	244	259	228	5	S	I	Same consistency as 3.
9	20	2, 27	28 days .	197	207	183	5	S	I	Same consistency as 4.
10	22	2, 27	28 days .	156	160	153	5	S	I	Same consistency as 5.
11	14	2, 28	7 days ..	84	106	74	5	S	I	Same consistency as 1.
12	16	2, 28	7 days ..	138	157	126	5	S	I	Same consistency as 2.
13	18.6	2, 28	7 days ..	111	125	104	5	S	I	About proper consistency.
14	20.9	2, 28	7 days ..	71	90	58	5	S	I	Moist; water oozed from beneath mold.
15	22.9	2, 28	7 days ..	65	77	58	4	S	I	Very moist, but would hold its shape.
16	14	2, 28	28 days .	173	197	154	5	S	I	Same consistency as 11.
17	16	2, 28	28 days .	238	267	207	5	S	I	Same consistency as 12.
18	18.6	2, 28	28 days .	244	264	226	5	S	I	Same consistency as 13.
19	20.9	2, 28	28 days .	196	204	188	5	S	I	Same consistency as 14.
20	22.9	2, 28	28 days .	153	158	148	5	S	I	Same consistency as 15.
21	14	3, 1	6 mos...	207	225	173	10	S	I	Same consistency as 11.
22	16	3, 1	6 mos...	255	273	230	10	S	I	Same consistency as 12.
23	18.6	3, 1	6 mos...	306	320	287	10	S	I	Same consistency as 13.
24	20.9	3, 1	6 mos...	297	317	270	10	S	I	Same consistency as 14. Briquets trifle porous.
25	22.9	3, 1	6 mos...	327	353	302	10	S	I	Same consistency as 15. Briquets somewhat porous.

TABLE 6.—NATURAL CEMENT WITH TWO PARTS, BY WEIGHT, OF "STANDARD" SAND.

[Cement sample 15 R, brand Gn.]

1	12.5	2, 21	28 days..	184	202	168	10	S	I	Dry.
2	13.9	2, 21	28 days..	186	204	168	10	S	I	Trifle dry.
3	15.3	2, 21	28 days..	166	178	140	10	S	I	About proper consistency.
4	16.7	2, 21	28 days..	139	148	124	10	S	I	Moist.
5	18.1	2, 21	28 days..	109	116	100	10	S	I	Very moist.
6	12.5	2, 23	6 mos...	226	245	205	10	S	I	Same as 1.
7	13.0	2, 23	6 mos...	260	282	240	10	S	I	Same as 2.
8	15.3	2, 23	6 mos...	287	307	260	10	S	I	Same as 3.
9	16.7	2, 23	6 mos...	313	337	294	10	S	I	Same as 4.
10	18.1	2, 23	6 mos...	303	315	288	10	S	I	Same as 5.
11	12.5	3, 24, 26	1 year...	190	220	173	10	S	I	Same as 1.
12	13.9	3, 24, 26	1 year...	232	249	189	10	S	I	Same as 2.
13	15.3	3, 24, 26	1 year...	288	314	266	10	S	I	Same as 3.
14	16.7	3, 24, 26	1 year...	291	325	272	10	S	I	Same as 4.
15	18.1	3, 24, 26	1 year...	323	338	273	10	S	I	Same as 5.

SERIES 33c.—*Variations in temperature of materials and air where gauged and molded.*

TABLE 1.—NEAT NATURAL CEMENT MORTAR.

[Sample 21R, brand Gn.]

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Temperatures (degrees F.).		Date made (November, 1892).	Age.	Tensile strength.					Time in molds (hours).	Total time in air where made (hours).	Time in damp closet, warm room (hours).	Molder.	Tank.	Covered with damp cloth till put in damp closet.
		Kind and fineness.	Parts to 1 cement.		Materials.	Air where made.			Mean.		Highest.	Lowest.	Number averaged.						
									Made in cold air.	Made in warm air.									
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*
									Lbs.	*Lbs.*	*Lbs.*	*Lbs.*							
1	Gn, 21R	....	0	31.7	45	45	7	7 days....	88	....	102	73	10	5	5	19	S	U	No.
2	Gn, 21R	....	0	31.7	67	67	7	8 days....	....	42	50	38	10	5	5	19	S	U	Yes.
3	Gn, 21R	....	0	31.7	45	45	7	28 days...	139	....	152	118	5	5	5	19	S	*U	No.
4	Gn, 21R	....	0	31.7	67	67	7	28 days...	....	106	112	90	5	5	5	19	S	*U	Yes.
5	Gn, 21R	....	0	31.7	46	45	7	3 mos	173	....	224	144	5	5	5	19	S	*U	No.
6	Gn, 21R	....	0	31.7	67	67	7	3 mos	....	143	158	125	5	5	5	19	S	U	Yes.
7	Gn, 21R	....	0	31.7	45	45	7	6 mos	185	....	213	154	5	5	5	19	S	U	No.
8	Gn, 21R	....	0	31.7	67	67	7	6 mos	....	146	183	119	5	5	5	19	S	U	Yes.
9	Gn, 21R	....	0	31.7	36	36	8	7 days....	94	....	122	75	10	5	5	19	S	U	No.
10	Gn, 21R	....	0	31.7	67	67	8	7 days....	....	44	50	37	10	5	5	19	S	U	Yes.
11	Gn, 21R	....	0	31.7	36	36	8	28 days...	139	....	152	126	5	5	5	19	S	U	No.
12	Gn, 21R	....	0	31.7	67	67	8	28 days...	....	84	90	76	5	5	5	19	S	†U	Yes.
13	Gn, 21R	....	0	31.7	36	36	8	3 mos	176	....	202	150	5	5	5	19	S	‡U	No.
14	Gn, 21R	....	0	31.7	67	67	8	3 mos	....	153	191	120	5	5	5	19	S	§U	Yes.
15	Gn, 21R	....	0	31.7	36	36	8	6 mos	194	....	226	163	5	5	5	19	S	‡U	No.
16	Gn, 21R	....	0	31.7	67	67	8	6 mos	....	140	146	132	5	5	5	19	S	‡U	Yes.
																19			

* All cracked in tank. † Four briquets were cracked. ‡ All briquets were cracked. § All briquets were cracked, lowest (120 lbs.) badly.

SERIES 33c.—*Variations in temperature of materials and air where gauged and molded*—Continued.

TABLE 2.—NEAT NATURAL CEMENT MORTAR.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Temperatures (degrees F.).		Date made (November, 1892).	Age.	Tensile strength.					Time in molds (hours).	Total time in air where made (hours).	Time in damp closet, warm room (hours).	Molder.	Tank.	Covered with damp cloth till put in damp closet.
		Kind and fineness.	Parts to 1 cement.		Materials.	Air where made.			Mean.		Highest.	Lowest.	Number averaged.						
									Made in cold air.	Made in warm air.									
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s
									Lbs.	Lbs.	Lbs.	Lbs.							
1	Gn, 21R	....	0	31.7	36	36	16	1 day	64	....	71	53	10	5	5	5	S	U	No.
2	Gn, 21R	....	0	31.7	65	65	16	1 day	....	54	61	44	10	5	5	5	S	U	No.
3	Gn, 21R	....	0	31.7	36	36	16	7 days	53	....	62	47	10	5	5	19	S	U	No.
4	Gn, 21R	....	0	31.7	65	65	16	7 days	....	42	48	32	10	5	5	19	S	U	No.
5	Gn, 21R	....	0	31.7	36	36	16	28 days	112	....	148	86	5	5	5	19	S	U	No.
6	Gn, 21R	....	0	31.7	65	65	16	28 days	....	90	106	80	5	5	5	19	S	U	No.
7	Gn, 21R	....	0	31.7	38	38	17	7 days	50	....	61	45	5	3	3	4	S	U	No.
8	Gn, 21R	....	0	31.7	65	65	17	7 days	....	43	45	41	5	3	3	4	S	U	No.
9	Gn, 21R	....	0	31.7	38	38	17	7 days	55	....	58	50	5	8	8	4	S	U	No.
10	Gn, 21R	....	0	31.7	65	65	17	7 days	....	38	43	33	5	8	8	4	S	U	No.
11	Gn, 21R	....	0	31.7	38	38	17	7 days	49	....	63	37	5	16	16	4	S	U	No.
12	Gn, 21R	....	0	31.7	65	65	17	7 days	....	44	48	41	5	16	16	4	S	U	No.
13	Gn, 21R	....	0	31.7	38	38	17	7 days	49	....	58	38	5	24	24	4	S	U	No.
14	Gn, 21R	....	0	31.7	65	65	17	7 days	....	50	57	42	5	24	24	4	S	U	No.
15	Gn, 21R	....	0	31.7	38	38	17	7 days	49	....	57	40	5	48	48	4	S	U	No.
16	Gn, 21R	....	0	31.7	65	65	17	7 days	....	64	73	54	5	48	48	4	S	U	No.

TABLE 3.—NATURAL CEMENT WITH ONE AND THREE PARTS SAND.

Reference.	Cement.	Kind and fineness.	Parts to 1 cement.	Water (per cent of dry ingredients).	Materials.	Air where made.	Date made (November, 1892).	Age.	Made in cold air.	Made in warm air.	Highest.	Lowest.	Number averaged.	Time in molds (hours).	Total time in air where made (hours).	Time in damp closet, warm room (hours).	Molder.	Tank.	Covered with damp cloth till put in damp closet.
1	Gn, 21R	St. 20–30	1	18.7	34	34	10	1 day	37	....	42	32	10	5	5	2½	S	U	No.
2	Gn, 21R	St. 20–30	1	18.7	67	67	10	1 day	....	51	60	44	10	3	8	0	S	U	Yes.
3	Gn, 21R	St. 20–30	1	18.7	34	34	9–10	7 days	77	....	93	64	20	5	5	19	S	U	No.
4	Gn, 21R	St. 20–30	1	18.7	67	67	9–10	7 days	....	67	82	55	20	3 to 5?	3 to 5?	19?	S	U	Yes.
5	Gn, 21R	St. 20–30	1	18.7	34	34	9–10	28 days	214	....	242	186	10	5	5	19	S	U	No.
6	Gn, 21R	St. 20–30	1	18.7	67	67	9–10	28 days	....	185	209	154	9	3 to 5	3 to 5?	19?	S	U	Yes.
7	Gn, 21R	St. 20–30	1	18.7	34	34	9	3 mos	399	....	427	342	5	5	5	19	S	U	No.
8	Gn. 21R	St. 20–30	1	18.7	67	67	9	3 mos	....	347	404	277	5	3 to 5	3 to 5	21 to 19	S	U	Yes.

9	Gn, 21R	St. 20-30	1	18.7	34	34	9	6 mos.....	438	....	448	428	5	5	5	19	S	U	No.
10	Gn, 21R	St. 20-30	1	18.7	67	67	9	6 mos.........		446	484	422	5	3 to 5	3 to 5	21 to 19	S	U	Yes.
11	Gn, 21R	St. 20-30	3	13.2	37	37	11	28 days...	110	....	135	80	10	12	12	12	S	U	No.
12	Gn, 21R	St. 20-30	3	13.2	67	67	11	28 days.........		65	83	50	10	12	12	12	S	U	Yes.
13	Gn, 21R	St. 20-30	3	13.2	37	37	11	3 mos ...	240	....	200	206	4	12	12	12	S	U	No.
14	Gn, 21R	St. 20-30	3	13.2	67	67	11	3 mos		250	263	238	5	12	12	12	S	U	Yes.
15	Gn, 21R	St. 20-30	3	13.2	37	37	11	6 mos....	312	....	327	300	5	12	12	12	S	U	No.
16	Gn, 21R	St. 20-30	3	13.2	67	67	11	6 mos		312	322	302	5	12	12	12	S	U	Yes.
17	Gn, 21R	St. 20-30	3	13.2	37	37	11	1 year....	234	....	255	210	4	12	12	12	S	U	No.
18	Gn, 21R	St. 20-30	3	13.2	67	67	11	1 year		267	294	232	5	12	12	12	S	U	Yes.

SERIES 33c.—*Variations in temperature of materials and air where gauged and molded*—Continued.

TABLE 4.—NEAT NATURAL CEMENT.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Temperatures (degrees F.).		Date made (April, 1893).	Age (days).	Tensile strength.					Time in molds (hours).	Total time in air where made (hours).	Time in damp closet, warm room (hours).	Molder.	Tank.	Covered with damp cloth until put in damp closet.	Mean tensile strengths.	
		Kind and fineness.	Parts to 1 cement.		Materials.	Air where made.			Mean.		Highest.	Lowest.	Number averaged.								
									Made in cold air.	Made in warm air.											
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	
									Lbs.	Lbs.	Lbs.	Lbs.									
1	Gn, 16R	....	0	32	37	37	11	7	65	....	76	54	5	4½	12	36	N	G	No....	62	66
2	Gn, 16R	....	0	32	37	37	11	7	60	....	72	54	5	4½	12	36	S	G	No....	..	
3	Gn, 16R	....	0	32	38	38	11	7	69	....	83	53	5	4½	24	24	N	G	No....	69	
4	Gn, 16R	....	0	32	38	38	11	7	69	....	78	61	5	4½	24	24	S	G	No....	..	
5	Gn, 16R	....	0	32	65	65	11	7	....	68	75	60	5	4½	12	36	N	G	No....	70	70
6	Gn, 16R	....	0	32	65	65	11	7	....	72	78	66	5	4½	12	36	S	G	No....	..	
7	Gn, 16R	....	0	32	65	65	11	7	....	71	78	62	5	4½	24	24	N	G	No....	71	
8	Gn, 16R	....	0	32	65	65	11	7	....	71	77	68	5	4½	24	24	S	G	No....	..	
9	Gn, 16R	....	0	32	39	39	11	28	73	....	84	69	5	4½	12	36	N	G	No....	76	75
10	Gn, 16R	....	0	32	39	39	11	28	80	....	96	70	5	4½	12	36	S	G	No....	..	
11	Gn, 16R	....	0	32	40	40	11	28	72	....	94	62	5	4½	24	24	N	G	No....	75	
12	Gn, 16R	....	0	32	40	40	11	28	78	....	98	70	5	4½	24	24	S	G	No....	..	
13	Gn, 16R	....	0	32	65	65	11	28	....	70	80	57	5	4½	12	36	N	G	No....	68	68
14	Gn, 16R	....	0	32	65	65	11	28	....	66	74	61	5	4½	12	36	S	G	No....	..	
15	Gn, 16R	....	0	32	65	65	11	28	....	70	82	61	5	4½	24	24	N	G	No....	69	
16	Gn, 16R	....	0	32	65	65	11	28	....	68	74	67	5	4½	24	24	S	G	No....	..	

SERIES 33c.—*Variations in temperature of materials and of air where made.*

TABLE 5.—NATURAL CEMENT WITH ONE PART STANDARD SAND.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Temperatures (degrees F.).		Date made (April, 1893).	Age (days).	Tensile strength.					Time in molds (hours).	Total time in air where made (hours).	Time in damp closet, warm room (hours).	Molder.	Tank.	Covered with damp cloth till put in damp closet.	Mean tensile strength.	
		Kind and fineness.	Parts to 1 cement.		Materials.	Air where made.			Mean.		Highest.	Lowest.	Number averaged.								
									Made in cold air.	Made in warm air.											
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*	
									Lbs.	*Lbs.*	*Lbs.*	*Lbs.*									
1	Gn. 21R	St. 20-30	1	18.75	39	39	12	7	70	....	76	65	5	6	12	36	N	G	No.	70	74
2	Gn, 21R	St. 20-30	1	18.75	39	39	12	7	71	....	79	64	5	6	12	36	S	G	No.		
3	Gn, 21R	St. 20-30	1	18.75	39	39	12	7	77	....	90	70	5	6	24	24	N	G	No.	78	
4	Gn, 21R	St. 20-30	1	18.75	39	39	12	7	79	....	88	73	5	6	24	24	S	G	No.		
5	Gn, 31R	St. 20-30	1	18.75	68	68	12	7	....	76	84	65	5	6	12	36	N	G	No.	77	76
6	Gn, 21R	St. 20-30	1	18.75	68	68	12	7	....	79	80	70	5	6	12	36	S	G	No.		
7	Gn. 21R	St. 20-30	1	18.75	68	68	12	7	....	79	94	67	5	6	24	24	N	G	No.	75	
8	Gn, 21R	St. 20-30	1	18.75	68	68	12	7	....	72	77	68	5	6	24	24	S	G	No.		
9	Gn, 21R	St. 20-30	1	18.75	39	39	12	28	133	....	144	126	5	6	12	36	N	G	No.	131	128
10	Gn, 21R	St. 20-30	1	18.75	39	39	12	28	129	....	140	116	5	6	12	36	S	G	No.		
11	Gn, 21R	St. 20-30	1	18.75	39	39	12	28	128	....	146	120	5	6	24	24	N	G	No.	126	
12	Gn, 21R	St. 20-30	1	18.75	39	39	12	28	124	....	136	120	5	6	24	24	S	G	No.		
13	Gn, 21R	St. 20-30	1	18.75	68	68	12	28	....	90	94	88	5	6	12	36	N	G	No.	91	93
14	Gn. 21R	St. 20-30	1	18.75	68	68	12	28	....	92	98	96	5	6	12	36	S	G	No.		
15	Gn, 21R	St. 20-30	1	18.75	68	68	12	28	....	96	104	88	5	6	24	24	N	G	No.	95	
16	Gn, 21R	St. 20-30	1	18.75	68	68	12	28	....	94	107	88	5	6	24	24	S	G	No.		

SERIES 33c.—*Variations in temperature of materials and of air where made*—Continued.

TABLE 6.—NEAT NATURAL CEMENT.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Temperatures (degrees F.).		Date made (1893).	Age.	Tensile strength.					Time in molds (hours).	Total time in air where made (hours).	Time in damp closet, warm room (hours).	Molder.	Tank.	Covered with damp cloth till put in damp closet.
		Kind and fineness.	Parts to 1 cement.		Materials.	Air where made.			Mean.		Highest.	Lowest.	Number averaged.						
									Made in cold air.	Made in warm air.									
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*
									Lbs.	*Lbs.*	*Lbs.*	*Lbs.*							
1	An, 13s	....	0	31.4	37	36	4, 28	1 day....	152	....	160	144	5	9½	12	12	S	(*)	
2	An, 13s	....	0	31.4	65	65	4, 28	1 day....	....	162	172	150	5	9½	12	12	S	(*)	No.
3	An, 13s	....	0	31.4	37	36	4, 28	1 day....	136	....	147	121	5	9½	24	(†)	S	(*)	No.
4	An, 13s	....	0	31.4	65	65	4, 28	1 day....	....	173	187	164	5	9½	24	(†)	S	(*)	No.
5	An, 13s	....	0	31.4	37	37	4, 26	7 days...	220	....	238	204	5	9½	12	36	S	G	No.
6	An, 13s	....	0	31.4	65	65	4, 26	7 days...	....	167	174	156	5	9½	12	36	S	G	No.
7	An, 13s	....	0	31.4	37	37	4, 26	7 days...	191	....	210	170	5	9½	24	24	S	G	No.
8	An, 13s	....	0	31.4	65	65	4, 26	7 days...	....	158	163	154	5	9½	24	24	S	G	No.
9	An, 13s	....	0	31.4	37	37	4, 26	28 days..	254	....	270	220	5	9½	12	36	S	G	No.
10	An, 13s	....	0	31.4	65	65	4, 26	28 days..	....	210	222	196	5	9½	12	36	S	G	No.
11	An, 13s	....	0	31.4	37	37	4, 26	28 days..	218	....	242	192	5	9½	24	24	S	G	No.
12	An, 13s	....	0	31.4	65	65	4, 26	28 days..	....	203	226	151	5	9½	24	24	S	G	No.
13	An, 13s	....	0	31.4	37	36	4, 28	3 mos ...	363	....	390	338	5	9½	12	36	S	G	No.
14	An, 13s	....	0	31.4	65	65	4, 28	3 mos ...	....	240	250	225	5	9½	12	30	S	G	No.
15	An, 13s	....	0	31.4	37	36	4, 28	3 mos ...	246	....	260	230	5	9½	24	24	S	G	No.
16	An, 13s	....	0	31.4	65	65	4, 28	3 mos ...	....	186	212	159	5	9½	24	24	S	G	No.

* Not immersed.

† Not in damp closet.

TABLE 7.—NATURAL CEMENT WITH STANDARD SAND.

Reference.	*a*	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*
1	An, 13s	St.20-30	1	18.75	40	38	4, 27	7 days ..	184	....	201	170	5	12	12	36	S	G	No.
2	An, 13s	St.20-30	1	18.75	65	65	4, 27	7 days ..	....	195	202	186	5	12	12	36	S	G	No.
3	An, 13s	St.20-30	1	18.75	40	38	4, 27	7 days ..	181	....	198	164	5	12	24	24	S	G	No.
4	An, 13s	St.20-30	1	18.75	65	65	4, 27	7 days ..	....	179	189	170	5	12	24	24	S	G	No.
5	An, 13s	St.20-30	1	18.75	40	38	4, 27	28 days .	254	....	282	228	5	12	12	36	S	G	No.
6	An, 13s	St.20-30	1	18.75	65	65	4, 27	28 days .	....	231	244	218	5	12	12	30	S	G	No.
7	An, 13s	St.20-30	1	18.75	40	38	4, 27	28 days .	251	....	264	238	5	12	24	24	S	G	No.
8	An, 13s	St.20-30	1	18.75	65	65	4, 27	28 days .	....	209	238	154	5	12	24	24	S	G	No.

9	An, 13s	St.20-30	2	15.3	37	37	4, 29	7 days ..	95	....	112	88	5	12	12	36	S	G	No.
10	An, 13s	St.20-30	2	15.3	65	65	4, 29	7 days .	....	96	102	93	5	12	12	36	S	G	No.
11	An, 13s	St.20-30	2	15.3	37	37	4, 29	7 days ..	126	....	140	114	5	12	24	24	S	G	No.
12	An, 13s	St.20-30	2	15.3	65	65	4, 29	7 days ..	....	89	100	82	5	12	24	24	S	G	No.
13	An, 13s	St.20-30	2	15.3	37	38	4, 20	28 days .	187	....	196	180	5	12	12	36	S	G	No.
14	An, 13s	St.20-30	2	15.3	65	65	4, 29	28 days .	....	150	154	138	5	12	12	36	S	G	No.
15	An, 13s	St.20-30	2	15.3	37	38	4, 29	28 days .	199	....	216	186	5	12	24	24	S	G	No.
16	An, 13s	St.20-30	2	15.3	65	65	4, 29	28 days .	....	134	146	122	5	12	24	24	S	G	No.

TABLE 8.—PORTLAND CEMENT.

1	H, 21s	....	0	20	36	36	11, 14	3 days ..	577	....	017	548	5	....	24	2	S	P	No.
2	H, 21s	....	0	20	65	65	11, 14	3 days .	....	655	670	638	5	....	24	2	S	P	Yes.
3	H, 21s	....	0	20	36	36	11, 14	7 days ..	673	....	742	642	10	....	24	2	S	P	No.
4	H, 21s	....	0	20	65	65	11, 14	7 days .	....	675	730	611	10	....	24	2	S	P	Yes.
5	H, 21s	....	0	20	36	36	11, 14	28 days .	740	....	758	725	5	....	24	2	S	P	No.
6	H, 21s	....	0	20	65	65	11, 14	28 days .	....	719	746	689	5	....	24	2	S	P	Yes.
7	H, 21s	....	0	20	36	36	11, 14	3 mos ...	741	....	782	642	5	....	24	2	S	P	No.
8	H, 21s	....	0	20	65	65	11, 14	3 mos. ..	....	707	786	618	5	....	24	2	S	P	Yes.
9	H, 21s	St.20-30	3	12	34	34	11, 15	7 days ..	251	....	272	235	10	....	28	4	S	P	No.
10	H, 21s	St.20-30	3	12	65	65	11, 15	7 days .	....	241	264	218	10	....	28	4	S	P	Yes.
11	H, 21s	St.20-30	3	12	34	34	11, 15	28 days .	381	....	395	364	5	....	28	4	S	P	No.
12	H, 21s	St.20-30	3	12	65	65	11, 15	28 days .	....	342	370	310	5	....	28	4	S	P	Yes.
13	H, 21s	St.20-30	3	12	34	34	11, 15	3 mos ...	512	....	524	510	5	....	28	4	S	P	No.
14	H, 21s	St.20-30	3	12	65	65	11, 15	3 mos .	....	460	478	448	5	....	28	4	S	P	Yes.
15	H, 21s	St.20-30	3	12	34	34	11, 15	6 mos ...	529	....	552	510	5	....	28	4	S	P	No.
16	H, 21s	St.20-30	3	12	65	65	11, 15	6 mos .	....	476	494	448	5	....	28	4	S	P	Yes.

SERIES 33*d*.—*Variations in temperature of immersing tanks.*

TABLE 1.—NATURAL CEMENT, SEVEN DAYS.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Immersed.				Date made.	Age (days).	Tensile strength.				Molder.
		Kind and fineness.	Parts to 1 of cement.		Tank.	Temperature (degrees F.).					Mean.	Highest.	Lowest.	Number averaged.	
						Mean.	Highest.	Lowest.							
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
									1892.		*Lbs.*	*Lbs.*	*Lbs.*		
1	Gn, 21R	....	0	31.7	*h*	59	60	57	*12, 8	7	76	88	68	10	S
2	Gn, 21R	....	0	31.7	*d*	60	62	50	12, 8	7	70	84	62	10	S
3	Gn, 21R	....	0	31.7	*g*	64	67	61	12, 8	7	63	77	48	10	S
4	Gn, 21R	....	0	31.7	*a*	65	68	63	12, 8	7	67	96	55	10	S
5	Gn, 21R	....	0	31.7	*b*	65	68	63	12, 8	7	77	88	68	10	S
6	Gn, 21R	....	0	31.7	*h*	58	59	57	12, 12	7	92	100	74	5	S
7	Gn, 21R	....	0	31.7	*d*	61	62	59	12, 12	7	78	83	70	5	S
8	Gn, 21R	....	0	31.7	*g*	63	66	62	12, 12	7	112	118	102	5	S
9	Gn, 21R	....	0	31.7	*b*	66	68	63	12, 12	7	92	102	80	5	S
10	Gn, 21R	Std. 20–30	1	18.75	*h*	58	59	57	12, 13	7	121	129	114	5	S
11	Gn, 21R	Std. 20–30	1	18.75	*d*	60	62	56	12, 13	7	110	130	98	5	S
12	Gn, 21R	Std. 20–30	1	18.75	*g*	63	66	62	12, 13	7	143	150	132	5	S
13	Gn, 21R	Std. 20–30	1	18.75	*b*	65	68	63	12, 13	7	111	128	96	5	S
14	Gn, 15R	....	0	31.6	*g*	53	55	51	†12, 23	7	106	140	94	10	S
15	Gn, 15R	....	0	31.6	*h*	58	61	56	12, 23	7	104	124	92	10	S
16	Gn, 15R	....	0	31.6	*d*	60	66	57	12, 23	7	104	116	88	10	S
17	Gn, 15R	....	0	31.6	*b*	65	67	61	12, 23	7	109	124	84	10	S
18	Gn, 15R	....	0	31.6	*a*	70	73	66	12, 23	7	124	148	96	10	S

* Fresh water in tanks December 8. † Fresh water in tanks December 20.

TABLE 2.—NEAT NATURAL CEMENT, SEVEN DAYS.

									1892.						
1	Gn, 15R	....	0	31.7	*g*	54	56	52	*12, 28	7	107	120	94	5	S
2	Gn, 15R	....	0	31.7	*h*	59	61	57	12, 28	7	103	115	97	5	S
3	Gn, 15R	....	0	31.7	*d*	60	63	58	12, 28	7	104	115	94	5	S
4	Gn, 15R	....	0	31.7	*b*	64	68	61	12, 28	7	106	120	86	5	S
5	Gn, 15R	....	0	31.7	*a*	70	71	68	12, 28	7	113	125	102	5	S
6	Gn, 15R	....	0	31.7	*g*	53	56	52	12, 31	7	104	118	88	5	S
7	Gn, 15R	....	0	31.7	*h*	58	60	57	12, 31	7	101	126	84	5	S
8	Gn, 15R	....	0	31.7	*d*	60	61	58	12, 31	7	104	110	92	5	S
9	Gn, 15R	....	0	31.7	*b*	66	66	61	12, 31	7	110	128	96	5	S
10	Gn, 15R	....	0	31.7	*a*	70	71	69	12, 31	7	111	125	99	5	S
									1893.						
11	Gn, 15R	....	0	31.7	*h*	38	39	36	†2, 1	7	146	167	120	10	S
12	Gn, 15R	....	0	31.7	*c*	49	51	46	2, 1	7	137	154	112	10	S
13	Gn, 15R	....	0	31.7	*d*	57	59	54	2, 1	7	125	151	93	10	S
14	Gn, 15R	....	0	31.7	*a*	70	74	66	2, 1	7	126	149	110	10	S
15	Gn, 15R	....	0	31.7	*g*	80	84	76	2, 1	7	154	166	136	10	S

* Fresh water in tanks December 20. † Fresh water in tanks January 14.

TABLE 3.—NEAT NATURAL CEMENT.

									1893.						
1	Gn, 15R	....	0	31.7	*h*	38	42	35	*1, 31	14	144	166	106	10	S
2	Gn, 15R	....	0	31.7	*c*	50	52	46	1, 31	14	131	143	110	10	S
3	Gn, 15R	....	0	31.7	*d*	58	60	55	1, 31	14	141	158	130	10	S
4	Gn, 15R	....	0	31.7	*a*	70	74	66	1, 31	14	193	210	174	10	S
5	Gn, 15R	....	0	31.7	*g*	80	84	86	1, 31	14	208	234	180	10	S
									1892.						
6	Gn, 15R	....	0	31.7	*g*	53	56	49	† 12, 28	14	125	130	118	5	S
7	Gn, 15R	....	0	31.7	*h*	58	61	56	12, 28	14	127	147	111	5	S
8	Gn, 15R	....	0	31.7	*d*	59	67	62	12, 28	14	131	144	122	5	S
9	Gn, 15R	....	0	31.7	*b*	64	68	61	12, 28	14	150	158	138	5	S
10	Gn, 15R	....	0	31.7	*a*	70	71	66	12, 28	14	144	156	131	5	S
									1893.						
11	Gn, 15R	....	0	31.7	*h*	38	43	34	*1, 30	28	166	198	146	10	S
12	Gn, 15R	....	0	31.7	*c*	49	53	45	1, 30	28	178	204	152	10	S
13	Gn, 15R	....	0	31.7	*d*	58	60	54	1, 30	28	184	215	151	10	S
14	Gn, 15R	....	0	31.7	*a*	70	74	64	1, 30	28	247	276	232	10	S
15	Gn, 15R	....	0	31.7	*g*	80	85	76	1, 30	28	280	310	239	10	S

* Fresh water in tanks January 14. † Fresh water in tanks December 20.

Series 33d.—*Variations in temperature of immersing tanks*—Continued.

Table 4.—NATURAL CEMENT, ONE PART SAND.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Immersed.				Date made.	Age (days).	Tensile strength.				Molder.
		Kind and fineness.	Parts to 1 of cement.		Tank.	Temperature (degrees F.).					Mean.	Highest.	Lowest.	Number averaged.	
						Mean.	Highest.	Lowest.							
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
									1892.		Lbs.	Lbs.	Lbs.		
1	Gn, 15R	St. 20-30	1	18.75	g	54	56	52	*12, 29	7	84	97	78	10	S
2	Gn, 15R	St. 20-30	1	18.75	h	59	61	57	12, 29	7	90	103	76	10	S
3	Gn, 15R	St. 20-30	1	18.75	d	60	63	58	12, 29	7	89	108	78	10	S
4	Gn, 15R	St. 20-30	1	18.75	b	64	68	61	12, 29	7	98	118	79	10	S
5	Gn, 15R	St. 20-30	1	18.75	a	70	71	68	12, 29	7	106	128	98	10	S
									1893.						
6	Gn, 15R	St. 20-30	1	18.75	h	38	42	36	†2, 4	7	83	97	71	10	S
7	Gn, 15R	St. 20-30	1	18.75	c	50	51	48	2, 4	7	88	114	78	10	S
8	Gn, 15R	St. 20-30	1	18.75	d	58	60	55	2, 4	7	93	105	74	10	S
9	Gn, 15R	St. 20-30	1	18.75	a	70	73	67	2, 4	7	88	100	77	10	S
10	Gn, 15R	St. 20-30	1	18.75	g	80	82	78	2, 4	7	121	132	114	10	S
11	Gn, 15R	St. 20-30	1	18.75	h	38	42	36	2, 3	14	84	100	70	10	S
12	Gn, 15R	St. 20-30	1	18.75	c	50	53	48	2, 3	14	111	139	99	10	S
13	Gn, 15R	St. 20-30	1	18.75	d	58	60	55	2, 3	14	123	150	106	10	S
14	Gn, 15R	St. 20-30	1	18.75	a	70	74	67	2, 3	14	150	173	136	10	S
15	Gn, 15R	St. 20-30	1	18.75	g	80	85	77	2, 3	14	191	205	173	10	S

* Fresh water in tanks December 20. † Fresh water in tanks January 14.

Table 5.—NATURAL CEMENT WITH ONE PART STANDARD SAND, TWENTY-EIGHT DAYS.

									1893.						
1	Gn, 21R	St. 20-30	1	18.7	h	38	42	35	*2, 2	28	96	117	88	10	S
2	Gn, 21R	St. 20-30	1	18.7	c	49	53	45	2, 2	28	148	170	132	10	S
3	Gn, 21R	St. 20-30	1	18.7	d	58	60	54	2, 2	28	189	222	160	10	S
4	Gn, 21R	St. 20-20	1	18.7	a	70	74	64	2, 2	28	237	254	196	10	S
5	Gn, 21R	St. 20-30	1	18.7	g	80	85	76	2, 2	28	288	306	262	10	S
									1892.						
6	Gn, 21R	St. 20-30	1	18.7	g	52	56	49	†12, 30	28	165	188	150	10	S
7	Gn, 21R	St. 20-30	1	18.7	h	57	60	55	12, 30	28	186	216	160	10	S
8	Gn, 21R	St. 20-30	1	18.7	d	59	61	56	12, 30	28	198	227	157	10	S
9	Gn, 21R	St. 20-30	1	18.7	b	63	66	60	12, 30	28	221	250	196	10	S
10	Gn, 21R	St. 20-30	1	18.7	a	70	76	62	12, 30	28	249	273	219	10	S

* Fresh water in tanks January 14. † Fresh water in tanks December 20.

SERIES 33*d*.—*Variations in temperature of immersing tanks*—Continued.

TABLE 6.—SUMMARY COMPILED FROM TABLES 1 TO 5.

			Sand.					Approximate temperature (38° F.).		50° F.	
Reference.	Details in Table No. ——	Cement.	Kind and fineness.	Parts to 1 of cement.	Water (per cent of dry ingredients).	Date made.	Age.	Actual mean temperature.	Tensile strength.	Temperature.	Strength.
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
									Lbs.		*Lbs.*
1	1	Gn, 21R		0	31.7	12, 8, '92	7 days				
2	1	Gn, 21R		0	31.7	12, 8, '92	7 days				
3	1	Gn, 21R		0	31.7	12, 12, '92	7 days				
4		Mean of 3		0			7 days				
5	1	Gn, 21R	St.	1	18.75	12, 13, '92	7 days				
6	1	Gn, 15R		0	31.6	12, 23, '92	7 days				
7	2	Gn, 15R		0	31.7	12, 28, '92	7 days				
8	2	Gn, 15R		0	31.7	12, 28, '92	7 days				
9	2	Gn, 15R		0	31.7	12, 31, '92	7 days				
10		Mean of 4		0			7 days				
11	2	Gn, 15R		0	31.7	2, 1, '93	7 days	38	146	49	137
12	3	Gn, 15R		0	31.7	12, 28, '92	14 days				
13	3	Gn, 15R		0	31.7	1, 31, '93	14 days	38	144	50	131
14		Mean of 2		0			14 days	38	144	50	131
15	3	Gn, 15R		0	31.7	1, 30, '93	28 days	38	166	50	178
16	4	Gn, 15R	St.	1	18.75	12, 29, '92	7 days				
17	4	Gn, 15R	St.	1	18.75	2, 4, '93	7 days	38	83	50	88
18		Mean of 2		1			7 days	38	83	50	88
19	4	Gn, 15R	St.	1	18.75	2, 3, '93	14 days	38	84	50	111
20	5	Gn, 15R	St.	1	18.75	2, 2, '93	28 days	38	96	49	148
21	5	Gn, 15R	St.	1	18.75	12, 30, '93	28 days				
22		Mean of 2		1			28 days	38	96	49	148

	52° F.		54° F.		58° F.		60° F.		64° F.		66 F.		70° F.		80° F.	
Reference.	Temperature.	Strength.	Temperature.	Strength.	Temperature.	Strength.	Temperature.	Strength.	Temperature.	Strength.	Temperature.	Strength.	Temperature.	Strength.	Temperature.	Strength.
	l	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*	*z*	*aa*
		Lbs.		*Lbs.*		*Lbs.*		*Lbs.*		*Lbs.*		*Lbs.*		*Lbs.*		*Lbs.*
1							59	76	64	63	65	77				
2							60	70	65	67						
3					58	92	61	78	63	112	66	92				
4					58	92	60	75	64	81	66	84				
5					58	121	60	110	63	143	65	111				
6			53	106	58	104	60	104	65	109			70	124		
7			54	107			59	103	64	106			70	113		
8							60	104								
9			53	104	58	101	60	104			66	110	70	111		
10			54	106	58	102	60	104	64	107	66	110	70	116		
11					57	125							70	126	80	154
12			53	125	58	127	59	131	64	150			70	144		
13					58	141							70	193	80	208
14			53	125	58	134	59	131	64	150			70	168	80	208
15					58	184							70	247	80	280
16			54	84	59	90	60	89	64	98			70	106		
17					58	93							70	88	80	121
18			54	84	58	91	60	89	64	98			70	97	80	121
19					58	123							70	150	80	191
20					58	189							70	237	80	288
21	52	165			57	186			63	221			70	249		
22	52	165			57	187			63	221			70	243	80	288

SERIES 33*d*.—*Variations in temperature of immersing tanks*—Continued.

TABLE 7.—NATURAL CEMENT, FOUR BRANDS; NEAT, SEVEN DAYS.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Immersed.				Date made.	Age.	Tensile strength.				Molder.
		Kind and fineness.	Parts to 1 of cement.		Tank.	Temperature (degrees F.).					Mean.	Highest.	Lowest.	Number averaged.	
						Mean.	Highest.	Lowest.							
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
									1893.		*Lbs.*	*Lbs.*	*Lbs*		
1	Gn, 24R	....	0	31.7	*c*	51	52	49	*1, 16	7 days..	127	141	106	10	S
2	Gn, 24R	....	0	31.7	*g*	52	54	50	1, 16	7 days..	130	142	111	10	S
3	Gn, 24R	....	0	31.7	*h*	57	58	55	1, 16	7 days..	123	140	106	10	S
4	Gn, 24R	....	0	31.7	*b*	62	64	61	1, 16	7 days..	127	148	110	10	S
5	Gn, 24R	....	0	31.7	*a*	70	76	62	1, 16	7 days..	131	138	121	10	S
6	Gn, 13R	....	0	31.7	*c*	51	52	50	1, 17	7 days..	68	73	60	10	S
7	Gn, 13R	....	0	31.7	*g*	52	54	51	1, 17	7 days..	66	79	51	10	S
8	Gn, 13R	....	0	31.7	*h*	57	58	54	1, 17	7 days..	66	78	55	10	S
9	Gn, 13R	....	0	31.7	*b*	63	64	61	1, 17	7 days..	60	72	52	10	S
10	Gn, 13R	....	0	31.7	*a*	70	76	62	1, 17	7 days..	72	85	61	10	S
11	An, 13s	....	0	31.4	*c*	51	52	49	1, 18	7 days..	129	139	107	10	S
12	An, 13s	....	0	31.4	*g*	52	53	50	1, 18	7 days..	123	150	98	10	S
13	An, 13s	....	0	31.4	*h*	56	58	54	1, 18	7 days..	125	140	113	10	S
14	An, 13s	....	0	31.4	*b*	62	64	61	1, 18	7 days..	121	140	112	10	S
15	An, 13s	....	0	31.4	*a*	70	76	62	1, 18	7 days..	144	161	128	10	S
16	Dn, 9s	....	0	35.7	*c*	51	52	49	1, 19	7 days..	61	95	46	10	S
17	Dn, 9s	....	0	35.7	*g*	52	53	50	1, 19	7 days..	73	96	63	10	S
18	Dn, 9s	....	0	35.7	*h*	56	58	54	1, 19	7 days..	65	103	50	10	S
19	Dn, 9s	....	0	35.7	*b*	62	64	61	1. 19	7 days..	74	119	59	10	S
20	Dn, 9s	....	0	35.7	*a*	70	76	62	1, 19	7 days..	104	168	66	10	S
21	En. 15s	....	0	30	*c*	50	52	48	1, 20	7 days..	147	165	128	8	S
22	En, 15s	....	0	30	*g*	52	53	50	1, 20	7 days..	147	162	137	8	S
23	En, 15s	....	0	30	*h*	56	57	54	1, 20	7 days..	161	187	140	8	S
24	En, 15s	....	0	30	*b*	62	64	61	1, 20	7 days..	149	168	121	8	S
25	En, 15s	....	0	30	*a*	70	76	62	1, 20	7 days..	149	178	128	8	S

* Fresh water in tanks, January 14.

TABLE 8.—LONGER TIME TESTS ON NATURAL CEMENT—NEAT.

									1893.						
1	Gn, 16R	....	0	32	Q	65	66	64	3, 13	7 days ..	73	86	62	5	S
2	Gn, 16R	....	0	32	K	50	50	50	3, 13	7 days ..	94	102	88	5	S
3	Gn, 16R	....	0	32	L	59	60	57	3, 13	7 days ..	87	93	78	5	S
4	Gn, 16R	....	0	32	Q	66	67	64	3, 13	28 days .	108	122	100	5	S
5	Gn, 16R	....	0	32	K	52	55	50	3, 13	28 days .	123	134	115	5	S
6	Gn, 16R	....	0	32	Q	66	69	63	3, 13	3 mos ...	315	392	269	5	S
7	Gn, 16R	....	0	32	K	55	67	50	3, 13	3 mos ...	254	266	238	5	S
8	Gn, 16R	....	0	32	L	61	69	57	3, 13	3 mos ...	303	326	295	5	S
9	Gn, 16R	....	0	32	Q	67	72	63	3, 13	6 mos ...	382	410	363	5	S
10	Gn, 16R	....	0	32	K	59	71	50	3, 13	6 mos ...	391	418	378	5	S
11	Gn, 16R	....	0	32	I	67	68	66	3, 23	7 days ..	80	89	68	5	S
12	Gn, 16R	....	0	32	F	(‡)	54	....	3, 23	7 days ..	82	103	69	5	S
13	Gn, 16R	....	0	32	L	60	61	58	3, 23	7 days ..	68	74	64	5	S
14	Gn. 16R	....	0	32	I	67	68	65	3, 23	28 days .	143	149	133	5	S
15	Gn, 16R	....	0	32	F	(‡)	55	....	3, 23	28 days .	137	146	131	5	S
16	Gn, 16R	....	0	32	I	67	72	62	3, 23	3 mos ...	316	342	302	5	S
*17	Gn, 16R	....	0	32	*F	60	....	....	3, 23	3 mos ...	226	276	185	5	S
18	Gn, 16R	....	0	32	L	62	72	55	3, 23	3 mos ...	348	385	294	5	S
19	Gn, 16R	....	0	32	I	68	74	59	3, 23	6 mos ...	418	455	379	5	S
†20	Gn, 16R	....	0	32	†F	62	74	54	3, 23	6 mos ...	350	398	303	5	S

* Temperature Tank F read for last two months only.
† Temperature Tank F read for last five months only.
‡ About.

SERIES 33*d*.—*Variations in temperature of immersing tanks*—Continued.

TABLE 9.—LONGER TIME TESTS ON NATURAL CEMENT WITH SAND.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Immersed.				Date made.	Age.	Tensile strength.				Molder.
						Temperature (degrees F.).									
		Kind and fineness.	Parts to 1 of cement.		Tank.	Mean.	Highest.	Lowest.			Mean.	Highest.	Lowest.	Number averaged.	
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
									1893.		Lbs.	Lbs.	Lbs.		
1	Gn, 16R	St. 20-30	1	19.5	Q	65	66	64	3, 14	7 days ..	71	73	64	5	S
2	Gn, 16R	St. 20-30	1	19.5	K	50	50	50	3, 14	7 days ..	76	80	72	5	S
3	Gn, 16R	St. 20-30	1	19.5	Q	66	67	64	3, 14	28 days .	174	196	166	5	S
4	Gn, 16R	St. 20-30	1	19.5	K	52	55	50	3, 14	28 days .	123	143	108	5	S
5	Gn, 16R	St. 20-30	1	19.5	L	60	62	57	3, 14	28 days .	166	177	154	5	S
6	Gn, 16R	St. 20-30	1	19.5	Q	66	69	63	3, 14	3 mos ...	407	446	348	5	S
7	Gn, 16R	St. 20-30	1	19.5	K	55	67	50	3, 14	3 mos ...	346	369	324	5	S
8	Gn, 16R	St. 20-30	1	19.5	Q	67	72	63	3, 16	6 mos ...	453	514	430	5	S
9	Gn, 16R	St. 20-30	1	19.5	K	59	71	50	3, 14	6 mos ...	474	531	441	5	S
10	Gn, 16R	St. 20-30	1	19.5	L	63	72	57	3, 14	6 mos ...	474	530	438	5	S
11	Gn, 16R	St. 20-30	1	18.75	I	66	68	66	3, 24	7 days ..	87	104	76	5	S
12	Gn, 16R	St. 20-30	1	18.75	F	......	‡54	....	3, 24	7 days ..	91	96	84	5	S
13	Gn, 16R	St. 20-30	1	18.75	L	60	61	58	3, 24	7 days ..	81	84	78	5	S
14	Gn, 16R	St. 20-30	1	18.75	I	67	68	65	3, 24	28 days .	153	168	134	5	S
15	Gn, 16R	St. 20-30	1	18.75	F	......	‡55	....	3, 24	28 days .	175	188	151	5	S
16	Gn, 16R	St. 20-30	1	18.75	I	67	72	62	3, 24	3 mos ...	437	472	386	5	S
17	Gn, 16R	St. 20-30	1	18.75	*F	60	....	....	3, 24	3 mos ...	376	412	326	5	S
18	Gn, 16R	St. 20-30	1	18.75	L	62	72	55	3, 24	3 mos ...	435	449	424	5	S
19	Gn, 16R	St. 20-30	1	18.75	I	68	74	59	3, 24	6 mos ...	526	561	484	5	S
20	Gn, 16R	St. 20-30	1	18.75	†F	62	72	54	3, 24	6 mos ...	467	495	438	5	S

* Temperature Tank F read for last two months only.
† Temperature Tank F read for last five months only.
‡ About.

TABLE 10.—LONGER TIME TESTS ON NATURAL CEMENT WITH TWO PARTS SAND.

									1893.						
1	Gn, 16R	St. 20-30	2	15.3	Q	66	67	64	3, 15	28 days .	116	121	110	5	S
2	Gn, 16R	St. 20-30	2	15.3	K	52	55	50	3, 15	28 days .	67	76	58	5	S
3	Gn, 16R	St. 20-30	2	15.3	L	60	62	57	3, 15	28 days .	99	105	95	5	S
4	Gn, 16R	St. 20-30	2	15.3	Q	66	69	63	3, 15	3 mos...	306	320	290	5	S
5	Gn, 16R	St. 20-30	2	15.3	K	55	67	50	3, 15	3 mos...	254	302	232	5	S
6	Gn, 16R	St. 20-30	2	15.3	Q	67	72	63	3, 15	6 mos...	349	410	305	5	S
7	Gn, 16R	St. 20-30	2	15.3	K	59	71	50	3, 15	6 mos...	361	377	335	5	S
8	Gn, 16R	St. 20-30	2	15.3	L	63	72	57	3, 15	6 mos...	381	426	345	5	S
9	Gn, 16R	St. 20-30	2	15.3	Q	67	*69	†65	....	1 year ..	397	427	275	5	S
10	Gn, 16R	St. 20-30	2	15.3	K	55	*65	†50	....	1 year ..	409	430	392	5	S
11	Gn, 16R	St. 20-30	2	15.3	I	66	68	65	3, 15	28 days .	124	141	110	5	S
12	Gn, 16R	St. 20-30	2	15.3	F	......	‡55	....	3, 15	28 days .	118	147	93	5	S
13	Gn, 16R	St. 20-30	2	15.3	L	60	63	58	3, 15	28 days .	135	149	118	5	S
14	Gn, 16R	St. 20-30	2	15.3	I	67	72	62	3, 15	3 mos...	362	385	339	5	S
15	Gn, 16R	St. 20-30	2	15.3	§F	60	....	....	3, 15	3 mos...	304	317	287	5	S
16	Gn, 16R	St. 20-30	2	15.3	I	68	74	59	3, 15	6 mos...	347	394	312	5	S
17	Gn, 16R	St. 20-30	2	15.3	‖F	62	74	54	3, 15	6 mos...	356	392	318	5	S
18	Gn, 16R	St. 20-30	2	15.3	L	64	72	55	3, 15	6 mos...	379	398	348	5	S
19	Gn, 16R	St. 20-30	2	15.3	I	67	*70	†65	3, 15	1 year ..	416	440	404	5	S
20	Gn, 16R	St. 20-30	2	15.3	F	58	*65	†54	3, 15	1 year ..	444	452	432	5	S

* Highest weekly mean.
† Lowest weekly mean.
‡ Temperature estimated.
§ Temperature of Tank F read for last two months only.
‖ Temperature of Tank F read for last five months only.

SERIES 33*d*.—*Variations in temperature of immersing tanks*—Continued.

TABLE 11.—SHOWING EFFECT OF STALE WATER.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Immersed.				Date made.	Age.	Tensile strength.				Molder.
		Kind and fineness.	Parts to 1 of cement.		Tank.	Temperature (degrees F.).					Mean.	Highest.	Lowest.	Number averaged.	
						Mean.	Highest.	Lowest.							
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
									1892.		*Lbs.*	*Lbs.*	*Lbs.*		
1	Gn, 21R	....	0	31.7	H	58	59	57	12, 12	7 days ..	115	129	104	5	S
2	Gn, 21R	....	0	31.7	L	61	63	60	12, 12	7 days ..	106	120	74	5	S
3	Gn, 21R	....	0	31.7	U	65	67	64	12, 12	7 days ..	41	62	30	5	S
4	Gn, 21R	....	0	31.7	Q	67	68	66	12, 12	7 days ..	103	108	90	5	S
5	Gn, 21R	St. 20-30	1	18.75	H	58	59	56	12, 13	7 days ..	142	154	118	5	S
6	Gn, 21R	St. 20-30	1	18.75	L	61	63	60	12, 13	7 days ..	125	133	108	5	S
7	Gn, 21R	St. 20-30	1	18.75	U	65	67	64	12, 13	7 days ..	77	80	64	5	S
8	Gn, 21R	St. 20-30	1	18.75	Q	67	68	66	12, 13	7 days ..	107	118	90	5	S
9	Gn, 21R	St. 20-30	2	14.7	H	59	61	58	12, 9	7 days ..	70	76	58	5	S
10	Gn, 21R	St. 20-30	2	14.7	L	62	64	60	12, 9	7 days ..	89	94	84	5	S
11	Gn, 21R	St. 20-30	2	14.7	U	65	66	64	12, 9	7 days ..	52	56	46	5	S
12	Gn, 21R	St. 20-30	2	14.7	I	67	69	66	12, 9	7 days ..	62	67	52	5	S
13	Gn, 21R	St. 20-30	2	14.7	Q	68	69	66	12, 9	7 days ..	67	72	59	5	S
14	Gn, 21R	St. 20-30	2	14.7	*H	60	72	47	12, 9	1 year ..	409	448	368	5	S
15	Gn, 21R	St. 20-30	2	14.7	†L	62	72	55	12, 9	1 year ..	373	392	354	5	S
16	Gn, 21R	St. 20-30	2	14.7	‡U	66	74	59	12, 9	1 year ..	401	436	380	5	S
17	Gn, 21R	St. 20-30	2	14.7	§I	67	74	62	12, 9	1 year ..	497	524	436	5	S
18	Gn, 21R	St. 20-30	2	14.7	‖Q	67	73	61	12, 9	1 year ..	474	524	428	5	S

* Fresh water in tank February 18, April 20, June 27, August 11, September 22, December 21, 1893.

† Fresh water in tank December 24, 1892; March 15, April 20, June 27, August 11, September 22, December 21, 1893.

‡ Fresh water in tank December 24, 1892; April 17, June 26, August 11, September 23, December 20, 1893.

§ Fresh water in tank December 27, 1892; April 20, June 26, August 11, September 23, December 20, 1893.

‖ Fresh water in tank December 27, 1892; March 15, April 20, June 26, August 11, September 22, December 21, 1893.

SERIES 33*f*.—*Varying time in moist air before immersion.*

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Date made.	Age.	Tensile strength.				Time in molds under damp cloth.	Time in damp closet.	Total time in moist air.	Time in tank.	Tank.	Molder.
		Kind and fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.						
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*
					1892.	*Dys*	*Lbs.*	*Lbs.*	*Lbs.*		*Hrs.*	*Hrs.*	*Hrs.*	*Dys. hrs*		
1	Gn, 21R	....	0	31.6	11, 12	7	47	52	44	5	1½	1	2½	6 21½	G	S
2	Gn, 21R	....	0	31.6	11, 12	7	43	52	36	5	1½	4	5½	6 18½	G	S
3	Gn, 21R	....	0	31.6	11, 12	7	48	59	41	5	1½	8	9½	6 14½	G	S
4	Gn, 21R	....	0	31.6	11, 12	7	43	50	34	5	1½	12	13½	6 10½	G	S
5	Gn, 21R	....	0	31.6	11, 12	7	47	55	44	5	1½	22	23½	6 0½	G	S
6	Gn, 21R	....	0	31.6	11, 12	28	100	124	83	5	1½	1	2½	27 21½	G	S
7	Gn, 21R	....	0	31.6	11, 12	28	95	106	84	5	1½	4	5½	27 18½	G	S
8	Gn, 21R	....	0	31.6	11, 12	28	100	125	88	5	1½	8	9½	27 14½	G	S
9	Gn, 21R	....	0	31.6	11, 12	28	110	138	102	5	1½	12	13½	27 10½	G	S
10	Gn, 21R	....	0	31.6	11, 12	28	92	105	80	5	1½	22	23½	27 0½	G	S
					1893.											
11	15R	....	0	31.7	2, 17	7	123	140	112	10	3½	4½	8	6 16	G	S
12	15R	....	0	31.7	2, 17	7	139	154	118	10	3½	20½	24	6	G	S
13	15R	....	0	31.7	2, 17	7	151	168	130	10	3½	44½	48	5	G	S
14	15R	....	0	31.7	2, 17	7	161	180	152	10	3½	68½	72	4	G	S
15	15R	....	0	31.7	2, 17	7	237	254	216	10	3½	*164½	168	0	....	S
16	15R	St.	1	18.7	2, 18	7	91	109	77	10	3½	4½	8	6 16	G	S
17	15R	St.	1	18.7	2, 18	7	106	118	98	10	3½	20½	24	6	G	S
18	15R	St.	1	18.7	2, 18	7	114	136	97	10	3½	44½	48	5	G	S
19	15R	St.	1	18.7	2, 18	7	114	145	104	10	3½	68½	72	4	G	S
20	15R	St.	1	18.7	2, 18	7	182	212	162	10	3½	*164½	168	0	....	S
21	16R	....	0	32	3, 30	28	110	129	92	10	2½	5½	8	27 16	G	S
22	16R	....	0	32	3, 30	28	106	123	74	10	2½	21½	24	27	G	S
23	16R	....	0	32	3, 30	28	109	128	91	10	2½	45½	48	26	G	S
24	16R	....	0	32	3, 30	28	89	111	79	10	2½	69½	72	25	G	S
25	16R	....	0	32	3, 30	28	113	128	96	10	2½	165½	168	21	G	S
26	16R	St.	1	18.7	3, 31	28	142	158	114	10	8½	4½	8	27 16	G	S
27	16R	St.	1	18.7	3, 31	28	138	152	125	10	3½	21½	24	27	G	S
28	16R	St.	1	18.7	3, 31	28	139	156	119	10	3½	45½	48	26	G	S
29	16R	St.	1	18.7	3, 31	28	152	180	126	10	3½	69½	72	25	G	S
30	16R	St.	1	18.7	3, 31	28	175	195	163	10	3½	165½	168	21	G	S
31	16R	St.	2	15.3	4, 1	28	102	117	90	10	3½	4½	8	27 16	G	S
32	16R	St.	2	15.3	4, 1	28	105	128	85	10	3½	21½	24	27	G	S
33	16R	St.	2	15.3	4, 1	28	112	133	88	10	3½	45½	48	26	G	S
34	16R	St.	2	15.3	4, 1	28	113	130	95	10	3½	69½	72	25	G	S
35	16R	St.	2	15.3	4, 1	28	115	138	92	10	3½	165½	168	21	G	S

* Damp closet till broken.

SERIES 33*g*.—*Variations in exposure for the twenty-four hours before immersion.*

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Date made (March, 1893).	Age.	Tensile strength.				Time in molds (hours).	Time exposed to dry air (hours).	Time under dry cloth (hours).	Time under wet cloth (hours).	Time in damp closet (hours).	Molder.	Tank.
		Kind and fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.							
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*
						Dys	*Lbs.*	*Lbs.*	*Lbs.*								
1	Gn. 16R	....	0	32	6	7	85	98	74	10	4	24	....	....	....	S	Q
2	Gn. 16R	....	0	32	6	7	72	84	64	10	4	....	....	24	....	S	Q
3	Gn, 16R	....	0	32	6	7	76	96	62	10	4	12	...	....	12	S	Q
4	Gn, 16R	....	0	32	6	7	71	84	56	10	4	....	12	..	12	S	Q
5	Gn, 16R	....	0	32	6	7	65	80	54	10	4	....	....	12	12	S	Q
6	Gn. 16R	St 20-30	1	19.5	7	7	72	87	62	10	4	24	....	....	....	S	Q
7	Gn, 16R	St. 20-30	1	19.5	7	7	67	78	60	10	4	....	....	24	....	S	Q
8	Gn, 16R	St. 20-30	1	19.5	7	7	63	74	51	10	4	12	....	....	12	S	Q
9	Gn, 16R	St. 20-30	1	19.5	7	7	62	72	56	10	4	....	12	....	12	S	Q
10	Gn, 16R	St 20-30	1	19.5	7	7	61	78	52	10	4	....	....	12	12	S	Q

SERIES 33*h*.—*Variations in method of filling molds.*

NATURAL CEMENT.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Date made (March, 1893).	Age.	Tensile strength.				Packed with—	Molder.	Tank.
		Kind and fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*q*	*h*	*i*	*j*	*k*	*l*	*m*
						Days	*Lbs.*	*Lbs.*	*Lbs.*				
[1] 1	Gn, 16R	....	0	31.7	8	7	67	76	58	10	Trowel....	S	Q
[2] 2	Gn, 16R	....	0	31.7	8	7	63	75	52	10	...do.......	S	Q
[3] 3	Gn, 16R	....	0	31.7	8	7	65	74	57	10	Fingers ...	S	Q
[4] 4	Gn, 16R	....	0	31.7	8	7	68	84	61	10	...do.......	S	Q
[1] 5	Gn, 16R	....	0	31.7	10	14	72	88	63	10	Trowel....	S	Q
[2] 6	Gn, 16R	....	0	31.7	10	14	75	84	63	10	...do.......	S	Q
[3] 7	Gn, 16R	....	0	31.7	10	14	77	97	60	10	Fingers....	S	Q
[4] 8	Gn, 16R	....	0	31.7	10	14	78	100	65	10	...do.......	S	Q
[1] 9	Gn, 16R	St. 20-30	1	18.75	9	7	77	95	68	10	Trowel....	S	Q
[2] 10	Gn, 16R	St. 20-30	1	18.75	9	7	70	76	64	10	...do.......	S	Q
[3] 11	Gn, 16R	St. 20-30	1	18.75	9	7	74	81	63	10	Fingers ...	S	Q
[4] 12	Gn, 16R	St. 20-30	1	18.75	9	7	74	88	65	10	...do.......	S	Q
[1] 13	Gn, 16R	St. 20-30	1	18.75	11	14	96	116	87	10	Trowel....	S	Q
[2] 14	Gn, 16R	St. 20-30	1	18.75	11	14	88	96	76	10	...do.......	S	Q
[3] 15	Gn, 16R	St. 20-30	1	18.75	11	14	97	103	88	10	Fingers ...	S	Q
[4] 16	Gn, 16R	St. 20-30	1	18.75	11	14	94	102	86	10	...do.......	S	Q

[1] Small amounts of mortar in mold and packed with trowel, pressed heavily on top with trowel.
[2] But two fillings to each mold, very little work expended. Pressed heavily on top with trowel.
[3] Small amounts of mortar in mold and packed with fingers. Pressed heavily on top with trowel.
[4] Very little work expended. Pressed heavily on top with trowel.

SERIES 33*i*.—*Variations in temperature of materials used in gauging.*

TABLE 1.—NEAT NATURAL-CEMENT MORTAR.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Temperature (degrees F.).		Date made (April, 1893).	Age.	Tensile strength.					Molder.	Tank.
		Kind and fineness.	Parts to 1 of cement.		Materials.	Air where made.			Mean.		Highest	Lowest.	Number averaged.		
									Cold materials.	Warm materials.					
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*
									Lbs.	*Lbs.*	*Lbs.*	*Lbs.*			
1	Gn, 16R	....	0	32	35	64	18	1 day ...	72	......	75	65	5	S	Q
2	Gn, 16R	....	0	32	65	65	18	1 day ...	......	76	80	75	5	S	Q
3	Gn, 16R	....	0	32	35	64	18	7 days ..	79	......	102	68	10	S	Q
4	Gn, 16R	....	0	32	65	65	18	7 days ..	......	75	88	63	10	S	Q
5	Gn, 16R	....	0	32	35	64	18	28 days .	95	......	100	88	5	S	Q
6	Gn, 16R	....	0	32	65	65	18	28 days .	......	95	101	88	5	S	Q
7	Gn, 16R	....	0	32	35	64	18	3 mos ...	376	......	408	346	5	S	Q
8	Gn, 16R	....	0	32	65	65	18	3 mos ...	......	366	385	333	5	S	Q

TABLE 2.—NATURAL CEMENT WITH STANDARD SAND.

1	Gn, 16R	St. 20-30	1	18.75	36	66	15	7 days ..	88	......	101	70	10	S	*Q
2	Gn, 16R	St. 20-30	1	18.75	65	65	15	7 days ..	......	81	90	71	10	S	*Q
3	Gn, 16R	St. 20-30	1	18.75	36	66	15	28 days	131	......	144	122	5	S	Q
4	Gn, 16R	St. 20-30	1	18.75	65	65	15	28 days.	......	122	138	104	5	S	Q
5	Gn, 16R	St. 20-30	1	18.75	36	66	15	3 mos ...	428	......	458	398	5	S	Q
6	Gn, 16R	St. 20-30	1	18.75	65	65	15	3 mos ...	......	412	463	374	5	S	Q
7	Gn, 16R	St. 20-30	1	18.75	36	66	15	6 mos ...	481	......	510	436	5	S	Q
8	Gn, 16R	St. 20-30	1	18.75	65	65	15	6 mos ...	......	486	532	464	5	S	Q
9	Gn, 16R	St. 20-30	2	15.3	37	65	19	28 days .	77	......	88	68	10	S	Q
10	Gn, 16R	St. 20-30	2	15.3	65	66	19	28 days .	......	78	88	64	5	S	Q
11	Gn, 16R	St. 20-30	2	15.3	37	65	19	3 mos ...	345	......	372	289	5	S	Q
12	Gn, 16R	St. 20-30	2	15.3	65	66	19	3 mos ...	......	356	365	330	5	S	Q
13	Gn, 16R	St. 20-30	2	15.3	37	65	19	6 mos ...	318	......	351	298	5	S	Q
14	Gn, 16R	St. 20-30	2	15.3	65	60	19	6 mos ...	......	350	364	340	5	S	Q
15	Gn, 16R	St. 20-30	2	15.8	37	65	19	1 year ..	411	......	425	383	5	S	Q
16	Gn, 16R	St. 20-30	2	15.3	65	66	19	1 year ..	......	427	452	373	5	S	Q

* Immersed 3½ hours after made.

SERIES 35.—*Strength of mortar made of mixture of Portland and natural cements.*

Reference.	Proportions.						Date made (January, 1893).	Age.	Tensile strength.				Molder.	Tank.
	Cement.			Sand, Point aux Pins Pass 10.	Water.									
	Natural, sample 54R., brand Gn.	Portland, sample 42m., brand R.	Per cent of Portland.		Amount.	Per cent of dry ingredients.			Mean.	Highest.	Lowest.	Number averaged.		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*
	gms	*gms.*		*gms.*	*c. c.*				*Lbs.*	*Lbs.*	*Lbs.*			
1	240	00	0	480	110	15.3	16	7 days ..	24	32	18	10	N	U
2	210	30	12.5	480	108	15.0	16	7 days ..	75	82	49	10	N	U
3	189	63	25	504	112	14.8	16	7 days ..	108	126	93	10	N	U
4	126	126	50	504	100	13.2	16	7 days ..	205	221	184	10	N	U
5	00	275	100	550	100	12.1	16	7 days ..	291	333	270	10	N	U
6	240	00	0	480	110	15.3	17	28 days .	123	138	104	10	N	U
7	210	30	12.5	480	108	15.0	17	28 days .	190	234	166	10	N	U
8	180	63	25	504	112	14.8	17	28 days .	219	240	190	10	N	U
9	126	126	50	504	100	13.2	17	28 days .	264	306	234	10	N	U
10	00	275	100	550	100	12.1	17	28 days .	357	426	310	10	N	U
11	240	00	0	480	110	15.3	18	6 mos...	322	361	289	10	N	U
12	210	30	12.5	480	108	15.0	18	6 mos...	300	333	281	10	N	U
13	189	63	25	504	112	14.8	18	6 mos...	378	415	335	10	N	U
14	126	126	50	504	100	13.2	18	6 mos...	425	494	388	10	N	U
15	00	275	100	550	100	12.1	18	6 mos...	550	635	478	10	N	U
16	240	00	0	480	110	15.3	19	1 year ..	291	337	264	10	N	U
17	210	30	12.5	480	108	15.0	19	1 year ..	336	383	298	10	N	U
18	189	63	25	504	112	14.8	19	1 year ..	360	375	337	10	N	U
19	126	126	50	504	100	13.2	19	1 year ..	441	491	404	10	N	U
20	00	275	100	550	100	12.1	19	1 year ..	574	606	538	10	N	U

SERIES 35*a*.—*Strength of mortar made of mixture of Portland and natural cements.*

Reference.	Proportions.						Date made (October, 1893).	Age.	Tensile strength.				Molder.	Tank.
	Cement.			Sand, Point aux Pins Pass 10.	Water.									
	Natural, sample 30 m., brand Gn.	Portland, sample 22m., brand R.	Per cent Portland.		Amount.	Per cent of dry ingredients.			Mean.	Highest.	Lowest.	Number averaged.		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*
	gms.	*gms.*		*gms.*	*c. c.*				*Lbs.*	*Lbs.*	*Lbs.*			
1	240	00	0	480	110	15.3	19	28 days .	218	255	197	10	N	U
2	210	30	12.5	480	108	15.0	19	28 days .	234	258	217	10	N	U
3	189	63	25	504	112	14.8	19	28 days .	253	272	217	10	N	U
4	126	126	50	504	100	13.2	19	28 days .	296	322	271	10	N	U
5	00	275	100	550	100	12.1	19	28 days .	399	428	369	10	N	U
6	240	00	0	480	110	15.3	20	6 mos ...	310	340	282	10	N	U
7	210	30	12.5	480	108	15.0	20	6 mos ...	342	377	303	10	N	U
8	189	63	25	504	112	14.8	20	6 mos ...	372	405	364	10	N	U
9	126	126	50	504	100	13.2	20	6 mos ...	480	527	444	10	N	U
10	00	275	100	550	100	12.1	20	6 mos ...	570	622	530	10	N	U

SERIES 37.—*Different exposures before immersion for hot-water tests of natural cement.*

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Date made (January, 1893).	Age (days).	Tensile strength.				Time in moist air (hours).	Time in vapor of steamer (hours).	Time immersed in hot water (hours).	Temperature of water in steamer (degree C.).	Molder.
		Kind and fineness.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.					
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
							Lbs.	Lbs.	Lbs.						
1	Gn, 54R	St. 20–30	2	14.7	27	7	137	200	138	5	10	2	6½	60	N
2	Gn, 54R	St. 20–30	2	14.7	27	7	153	167	144	5	12	0	6½	60	N
3	Gn, 54R	St. 20–30	2	14.7	27	7	179	185	176	5	20	4	6	60	N
4	Gn, 54R	St. 20–30	2	14.7	27	7	173	189	152	5	22	2	6	60	N
5	Gn, 54R	St. 20–30	2	14.7	27	7	163	172	159	5	24	0	6	60	N
6	Gn, 54R	St. 20–30	2	14.7	27	9	185	216	155	5	10	2	8½	60	N
7	Gn, 54R	St. 20–30	2	14.7	27	9	189	212	154	5	12	0	8½	60	N
8	Gn, 54R	St. 20–30	2	14.7	27	9	185	206	155	5	20	4	8	60	N
9	Gn, 54R	St. 20–30	2	14.7	27	9	171	182	144	5	22	2	8	60	N
10	Gn, 54R	St. 20–30	2	14.7	27	9	187	202	175	5	24	0	8	60	N
11	An, 13s	St. 20–30	2	12.9	12	7	315	339	276	5	24	0	6	80	N
12	An, 13s	St. 20–30	2	12.9	12	7	270	294	246	5	45	3	5	80	N
13	An, 13s	St. 20–30	2	12.9	12	7	261	272	249	5	48	0	5	80	N
14	An, 13s	St. 20–30	2	12.9	12	9	276	296	250	5	24	0	8	80	N
15	An, 13s	St. 20–30	2	12.9	12	9	263	280	245	5	45	3	7	80	N
16	An, 13s	St. 20–30	2	12.9	12	9	254	281	233	5	48	0	7	80	N

SERIES 38.—*Hot-water tests for natural cement.*

Reference.	Cement.	Parts sand to 1 of cement.	Water (per cent of dry ingredients).	Date made (January, 1893).	Age (days).	Tensile strength.				Time in moist air (hours).	Time in vapor (hours).	Temperature of steamer (degrees C.).	Molder.	Mean tensile strength at 2 years, 3 parts sand, made 12, 15, '91, and 1, 28, '92 (ordinary temperature).
						Mean.	Highest.	Lowest.	Number averaged.					
	a	b	c	d	e	f	g	h	i	j	k	l	m	n
						Lbs.	Lbs.	Lbs.						
1	An, 13s	2	15	28	7	232	246	219	5	24	......	60	S	270
2	Bn, 10s	2	15.8	28	7	78	92	66	5	24	......	60	S	139
3	Dn, 9s	2	16.1	28	7	121	132	112	5	24	......	60	S	221
4	Fn, 19s	2	14.7	28	7	183	215	155	5	24	......	60	S	268
5	En, 15s	2	14.7	28	7	191	271	168	5	24	......	60	S	224
6	An, 13s	2	15	28	10	289	300	276	5	24	......	60	S	......
7	Bn, 10s	2	15.8	28	10	78	82	74	5	24	......	60	S	......
8	Dn. 9s	2	16.1	28	10	125	132	117	5	24	......	60	S	......
9	Fn, 19s	2	14.7	28	10	186	206	168	5	24	......	60	S	......
10	En, 15s	2	14.7	28	10	231	245	222	5	24	......	60	S	......
11	An, 13s	3	13.2	3	4	130	144	117	5	21	3	80	N	......
12	Bn, 10s	3	13.4	3	4	21	26	12	5	21	3	80	N	......
13	Fn, 19s	3	13.2	3	4	61	64	59	5	21	3	80	N	......
14	Gn, 54R	3	13.2	3	4	93	98	86	5	21	3	80	N	......
15	An, 13s	3	13.2	3	7	181	206	150	5	21	3	80	N	......
16	Bn, 10s	3	13.4	3	7	18	23	19	4	21	3	80	N	......
17	Fn, 19s	3	13.2	3	7	9	9	9	1	21	3	80	N	......
18	Gn, 54R	3	13.2	3	7	85	104	68	5	21	3	80	N	......
19	An, 13s	3	13.2	4	4	98	110	86	5	18	6	80	N	......
20	Bn, 10s	3	14.5	4	4	14	18	10	2	18	6	80	N	......
21	Fn, 19s	3	13.2	4	4	66	70	60	5	18	6	80	N	......
22	An, 13s	3	13.2	4	7	130	136	120	5	18	6	80	N	......
23	Bn, 10s	3	14.5	4	7	12	14	10	4	18	6	80	N	......
24	Fn, 19s	3	13.2	4	7	8	10	6	4	18	6	80	N	......

SERIES 40.—*Rate of increase in strength of a sample of natural cement with standard sand.*

Reference.	Cement.		Parts of sand to 1 of cement.	Water (per cent of dry ingredients).	Date made (April, 1893).	Age.	Tensile strength.				Molder.	Tank.
	Brand.	Sample.					Mean.	Highest.	Lowest.	Number averaged.		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*
							Lbs.	*Lbs.*	*Lbs.*			
1	Gn	16R	1	18.7	3	7 days ...	94	103	87	5	S	U
2	Gn	16R	1	18.7	3	28 days ..	142	177	126	5	S	U
3	Gn	16R	1	18.7	3	2 mos	334	338	327	5	S	U
4	Gn	16R	1	18.7	3	3 mos	399	440	374	5	S	U
5	Gn	16R	1	18.7	3	4 mos	431	458	411	5	S	U
6	Gn	16R	1	18.7	3	5½ mos ...	470	500	442	5	S	U
7	Gn	16R	1	18.7	3	6 mos	430	463	379	5	S	U
8	Gn	16R	1	18.7	3	9 mos	460	490	428	5	S	U
9	Gn	16R	1	18.7	3	1 year ...	500	561	451	5	S	U
10	Gn	16R	1	18.7	3	2 years ..	....	....	....	....	....	....
11	Gn	16R	2	15.3	4	7 days ...	59	66	52	5	S	U
12	Gn	16R	2	15.3	4	28 days ..	101	120	84	5	S	U
13	Gn	16R	2	15.3	4	2 mos	289	334	250	5	S	U
14	Gn	16R	2	15.3	4	3 mos	341	392	316	5	S	U
15	Gn	16R	2	15.3	4	4 mos	368	424	328	5	S	U
16	Gn	16R	2	15.3	4	5 mos	335	409	290	5	S	U
17	Gn	16R	2	15.3	4	6 mos	335	371	285	5	S	U
18	Gn	16R	2	15.3	4	9 mos	324	391	297	5	S	U
19	Gn	16R	2	15.3	4	1 year ...	386	424	330	5	S	U
20	Gn	16R	2	15.3	4	2 years ..	....	....	....	....	....	....
21	Gn	16R	3	13.2	5	28 days ..	73	81	65	5	S	U
22	Gn	16R	3	13.2	5	2 mos	204	232	181	5	S	U
23	Gn	16R	3	13.2	5	3 mos	243	260	230	5	S	U
24	Gn	16R	3	13.2	5	4 mos	254	278	226	5	S	U
25	Gn	16R	3	13.2	5	5 mos	259	274	235	5	S	U
26	Gn	16R	3	13.2	5	6 mos	252	275	234	5	S	U
27	Gn	16R	3	13.2	5	9 mos	247	272	228	5	S	U
28	Gn	16R	3	13.2	5	1 year ...	268	291	258	5	S	U
29	Gn	16R	3	13.2	5	2 years ..	....	....	....	....	....	....
30	Gn	16R	3	13.2	5	3 years ..	....	....	....	....	....	....

SERIES 45.—*Effect of heating materials for Portland cement mortar in freezing weather.*

[Cement sample 19m, brand R; sand P P, pass 10.]

Reference.	Parts of sand to 1 of cement.	Water (per cent of dry ingredients).	Temperatures.				Date made.	Age when broken (months).	Tensile strength.					Time in molds.	Time in warehouse where made.	Where stored.	Molder.	Remarks.
			Materials.	Air where molded.	Mortar when gauged.	Time required for mortar to reach 32° F.			Mean. Cold materials.	Mean. Warm materials.	Highest.	Lowest.	No. averaged.					
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q.	
			° F.	° F.	° F.	Mins.	1892.		Lbs.	Lbs.	Lbs.	Lbs.		hrs.	hrs.			
1	1	12.5	32	26	......	......	12, 19	9	541	......	607	490	10	20	53	Open air......	S.	Dry.
2	1	15	32	26	......	......	12, 19	9	485	......	514	414	5	16	49	Open air......	S.	Moist; briquets raised in molds; broken section porous.
3	1	15	100	26	94	26	12, 19	9	......	509	539	437	5	17	50	Open air......	S.	Trifle dry.
4	1	13.7	82	26	......	......	12, 19	9	597	......	579	541	5	16	49	Open air......	S.	
5	1	13.7	100	26	90	28	12, 19	9	......	524	603	443	5	17	50	Open air......	S.	Very dry.
6	1	15	32	20	......	......	12, 21	9	494	......	532	437	10	21	30	Canal.........	S.	Briquets raised in molds; broken section porous.
7	1	15	100	20	95 95	17 21	12, 21	9	......	515	574	470	10	21	25	Canal.........	S.	
8	2	12.1	82	27	......	11	12, 17	9	598	......	691	533	9	....	....	Open air......	S.	Trifle moist.
9	2	12.1	100	27	85 89	18 30	12, 17	9	......	465	513	384	10	....	....	Open air......	S.	
10	2	12.1	30	26	......	......	12, 19	9	389	......	520	342	10	4	55	Open air......	S.	Briquets porous on broken section.
11	2	12.1	100	26	90 97	32 23	12, 19	9	......	534	562	469	10	21	54	Open air......	S.	
12	2	12.1	32	20	......	......	12, 21	9	317	......	376	230	10	21	30	Canal.........	S.	Mixing box below 32° for 5 briquets; mean of 5 was 278 pounds; mean of others, 355 pounds.
13	2	12.1	100	20	95 93	17 21	12, 21	9	......	366	406	310	10	21	30	Canal.........	S.	

SERIES 46.—*Effect of heating materials for natural cement mortar in freezing weather*—Continued.

[Cement, sample 54 R., brand Gn.]

Reference.	Parts of sand to 1 of cement.	Water (per cent of dry ingredients).	Temperatures.				Date made.	Age when broken (months).	Tensile strength.					Time in molds.	Time in warehouse where made.	Where stored.	Molder.	Remarks.
			Materials.	Air where molded.	Mortar when gauged	Time required for mortar to reach 32° F.			Mean.		Highest.	Lowest.	No. averaged.					
									Cold materials.	Warm materials.								
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	
			° F.	° F.	° F.	Mins.	1892.		Lbs.	Lbs.	Lbs.	Lbs.		hrs.	hrs.			
1	2	15.3	32	22	35	6	12, 20	9	167	......	198	144	10	4	31	Canal.........	S.	Trifle dry.
2	2	15.3	100	22	95 87	19 15	12, 20	9	......	204	221	184	10	4	29	Canal.........	S.	Very dry; mixing box, 100° F.
3	2	15.3	32	24	......	......	12, 20	9	355	......	418	230	10	4	26	Open air......	S.	Trifle dry.
4	2	15.3	100	24	96 96	20 18	12, 20	9	......	361	432	303	10	4	25	Open air......	S.	Very dry; mixing box, 100° F.
5	3	13.2	32	19	......	......	12, 22	9	175	......	205	152	10	4	26	Canal.........	S.	In open air 6 days before immersed.
6	3	13.2	100	15	90 90	20 19	12, 22	9	......	203	228	186	10	4	30	Canal.........	S.	Trifle dry; mixing box, 100° F.
7	3	13.2	32	19	......	......	12, 22	......	......	......	......	......	......	4	25	....	S.	
8	3	13.2	100	15	92 93	20 24	12, 22	......	......	......	......	......	......	4	29	....	S.	
9	3	13.2	32	16	......	......	1893. 2, 16	6	140	......	161	124	10	....	24	Canal.........	S.	Briquets raised in molds with frost.
10	3	13.2	100	15	97 94	21 21	2, 16	6	......	151	176	139	10	....	24	Canal.........	S.	Trifle dry; briquets raised in molds with frost.
11	3	13.2	32	15	......	......	2, 16	6	311	......	370	250	10	....	24	Open air......	S.	Briquets raised in molds with frost.
12	3	13.2	100	16	96 97	24 23	2, 16	6	......	372	458	263	10	....	24	Open air......	S.	Trifle dry; briquets raised in molds with frost.

SERIES 50.—*Rates of increase in strength in air and water.*

Reference.	Cement.					Sand standard (parts to 1 of cement.)	Water (per cent of dry ingredients).	Tensile strength (pounds).																	
								Briquets stored in fresh water.									Briquets stored in dry air of test room.								
	Portland or natural.	Brand and barrel.	Fineness, per cent passing sieve holes, 0.0046 inch square.	Time to bear 1/12-inch wire weighing ¼ lb., neat cement.	Specific gravity.			1 day.	3 days.	7 days.	14 days.	28 days.	3 months.	6 months.	1 year.	2 years.	1 day.	3 days.	7 days.	14 days.	28 days.	3 months.	6 months.	1 year.	2 years.
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*	*q*	*r*	*s*	*t*	*u*	*v*	*w*	*x*	*y*
1	N	Hn, 26s	79.85	44	3.115	0	28.3	81	161	192	232	305	390	437	......	......	152	206	254	315	473	551	373	......	....
2	N	Hn, 26s	79.85	44	3.115	2	13.3	......	......	135	......	232	367	409	......	......	......	......	142	......	271	459	475	......	....
3	P	R, 12R	89.5	15	3.086	1	12.5	......	......	465	......	617	760	798	......	......	......	......	544	......	594	764	908	......	....
4	P	R, 12R	89.5	15	3.086	2	12.1	......	......	354	......	456	607	638	......	......	......	......	374	......	472	642	750	......	....
5	N	Gn, 84R	82.7	150	3.012	2	11.4	......	......	......	......	190	251	......	......	......	......	......	......	......	197	135	......	......	....
6	N	Gn, 84R	82.7	150	3.012	2	13.3	......	......	......	......	190	392	......	......	......	......	......	......	......	188	183	......	......	....
7	N	Gn, 84R	82.7	150	3.012	2	15.3	......	......	......	......	157	334	......	......	......	......	......	......	......	111	188	......	......	....
8	N	Gn, 84R	82.7	150	3.012	2	17.2	......	......	......	......	130	274	......	......	......	......	......	......	......	124	113	......	......	....
9	N	Gn, 84R	82.7	150	3.012	2	19.2	......	......	......	......	105	236	......	......	......	......	......	......	......	72	96	......	......	....
10	P	R, 18R	84.8	151	3.058	2	10.0	......	......	340	......	383	......	......	......	......	......	......	407	......	506	......	......	......	....
11	P	R, 18R	84.8	151	3.058	2	11.9	......	......	310	......	378	......	......	......	......	......	......	341	......	468	......	......	......	....
12	P	R, 18R	84.8	151	3.058	2	14.0	......	......	226	......	314	......	......	......	......	......	......	263	......	345	......	......	......	....
13	P	R, 18R	84.8	151	3.058	2	16.0	......	......	191	......	291	......	......	......	......	......	......	230	......	393	......	......	......	....
14	P	R, 18R	84.8	151	3.058	2	17.8	......	......	158	......	249	......	......	......	......	......	......	202	......	302	......	......	......	....

SERIES 51a.—*Variations in consistency of mortar.*

TABLE 1.—NEAT NATURAL CEMENT MORTAR.

[Cement, brand Ln, sample 31s.]

Reference.	Water (per cent of dry ingredients).	Date made (December, 1893).	Age.	Tensile strength				Molder.	Tank.	Time in molds (hours).	Air holes at broken section.	Remarks.
				Mean.	Highest.	Lowest.	Number averaged.					
	a	b	c	d	e	f	g	h	i	j	k	
				Lbs.	Lbs.	Lbs.						
1	25	11	1 day...	162	196	130	5	S	G	1½	....	Dry; briqutes showed slight moisture.
2	30	11	1 day...	148	156	140	5	S	G	1½	Some ..	Proper consistency.
3	35	11	1 day...	97	110	84	5	S	G	1½	Many ..	Moist.
4	40	11	1 day...	63	64	60	5	S	G	1	....	Very moist.
5	45	11	1 day...	36	42	34	5	S	G	3	Few ...	Just hold its shape. Flow when jarred lightly. Shrank in molds.
6	25	11	7 days..	178	211	142	5	S	G	1½	....	Same as 1.
7	30	11	7 days..	177	184	103	5	S	G	1½	Few ...	Same as 2.
8	35	11	7 days..	124	136	114	5	S	G	1½	Some ..	Same as 3.
9	40	11	7 days..	71	74	67	5	S	G	1	....	Same as 4.
10	45	11	7 days..	45	50	38	5	S	G	3	....	Same as 5.
11	25	12	28 days.	207	247	146	5	S	G	1	....	Same as 1.
12	30	12	28 days.	257	267	240	5	S	G	1½	....	Same as 2.
13	35	12	28 days.	202	211	182	5	S	G	2	....	Same as 3.
14	40	12	28 days.	140	152	125	5	S	G	1½	....	Same as 4.
15	45	12	28 days.	88	97	80	5	S	G	2	....	Same as 5.
16	25	12	3 mos...	300	355	238	5	S	G	1	....	Same as 1.
17	30	12	3 mos...	389	414	336	5	S	G	1½	....	Same as 2.
18	35	12	3 mos...	333	359	287	5	S	G	2	....	Same as 3.
19	40	12	3 mos...	264	292	243	5	S	G	1½	....	Same as 4.
20	45	12	3 mos...	197	225	166	5	S	G	2	....	Same as 5.

SERIES 51*a*.—*Variations in consistency of mortar*—Continued.

TABLE 2.—NATURAL CEMENT WITH ONE PART OF STANDARD SAND.

[Cement, brand Ln, sample 31s.]

Reference.	Water (per cent of dry ingredients).	Date made (December, 1893).	Age.	Tensile strength.				Molder.	Tank.	Time in molds (hours).	Remarks.
				Mean.	Highest.	Lowest.	Number averaged.				
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	
				Lbs.	*Lbs.*	*Lbs.*					
1	10	13	7 days ..	76	94	56	5	S	G	1	Very dry; briquets showed no moisture when finished.
2	15	13	7 days ..	151	172	133	5	S	G	1½	Dry, but showed some moisture when finished.
3	20	13	7 days ..	120	136	94	5	S	G	2	Trifle moist. Water oozed freely from under molds when pressed on top.
4	25	13	7 days ..	58	68	46	5	S	G	5	Very moist, but would hold its shape. Water ran out from under mold.
5	30	13	7 days ..	29	32	22	5	S	G	9½	Consistency of very thick cream. Briquets shrank in molds.
6	10	13	28 days .	109	132	82	5	S	G	1	Same as 1.
7	15	13	28 days .	225	243	210	5	S	G	1½	Same as 2.
8	20	13	28 days .	232	246	212	5	S	G	2	Same as 3.
9	25	13	28 days .	125	132	114	5	S	G	5	Same as 4.
10	30	13	28 days .	79	82	72	5	S	G	9½	Same as 5.
11	10	14	3 mos ...	138	152	120	5	S	G	1	Same as 1.
12	15	14	3 mos ...	322	338	290	5	S	G	1½	Same as 2.
13	20	14	3 mos ...	380	416	347	5	S	G	2	Same as 3.
14	25	14	3 mos ...	322	341	296	5	S	G	5	Same as 4.
15	30	14	3 mos ...	221	242	199	5	S	G	9	Same as 5.

TABLE 3.—NATURAL CEMENT WITH THREE PARTS STANDARD SAND.

[Sample 31s, brand Ln.]

1	8.5	15	7 days ..	62	70	56	5	S	G	1	Dry; briquets showed no moisture when finished.
2	12.5	15	7 days ..	42	48	32	5	S	G	2	About proper consistency.
3	16.5	15	7 days ..	22	24	20	5	S	G	3	Trifle moist.
4	20.5	15	7 days ..	13	18	8	5	S	G	10	Moist.
5	24.5	15	7 days ..	3	...	......	1	S	G	11	Very moist, but would hold its shape.
6	8.5	15	28 days .	108	137	80	5	S	G	1	Same as 1.
7	12.5	15	28 days .	104	111	92	5	S	G	2	Same as 2.
8	16.5	15	28 days .	84	88	81	5	S	G	3	Same as 3.
9	20.5	15	28 days .	54	59	50	5	S	G	10	Same as 4.
10	24.5	15	28 days .	36	44	30	4	S	G	11	Same as 5.
11	8.5	16	3 mos ...	148	166	124	5	S	G	1	Same as 1.
12	12.5	16	3 mos ...	224	240	210	5	S	G	2	Same as 2.
13	16.5	16	3 mos ...	176	190	148	5	S	G	3	Same as 3.
14	20.5	16	3 mos ...	102	114	88	5	S	G	10½	Same as 4.
15	24.5	16	3 mos ...	78	84	72	5	S	G	11	Same as 5.
16	8.5	16	6 mos ...	.....	.....	.....	....	....	....	1	Same as 1.
17	12.5	....	....	.....	.....	.....	....	....	....	2	Same as 2.
18	16.5	....	....	.....	.....	.....	....	....	....	3	Same as 3.
19	20.5	....	....	.....	.....	.....	....	....	....	10½	Same as 4.
20	24.5	....	....	.....	.....	.....	....	....	....	11	Same as 5.

SERIES 51*a*.—*Variations in consistency of mortar*—Continued.

TABLE 4.—NEAT NATURAL CEMENT, THREE BRANDS.

Reference.	Cement (brand and sample).	Water (per cent of dry ingredients).	Date made (December, 1893).	Age (days).	Tensile strength.				Molder.	Tank.	Time in molds (hours).	Air holes at broken section.	Remarks.
					Mean (pounds).	Highest (pounds).	Lowest (pounds).	Number averaged.					
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	
1	Gn, 83 R	25	4	7	113	114	112	2	S	G	4	....	Very dry; showed no moisture when finished.
2	Gn, 83 R	30	4	7	205	210	200	2	S	G	4	....	Trifle dry.
3	Gn, 83 R	35	4	7	122	126	118	2	S	G	4	Some ..	Trifle moist.
4	Gn, 83 R	40	4	7	72	76	68	2	S	G	4	...do ...	Moist.
5	Gn, 83 R	45	4	7	51	56	46	2	S	G	4	Many ..	Very moist.
6	Gn, 84 R	25	4	7	92	92	92	2	S	G	3	....	Same as 1.
7	Gn, 84 R	30	4	7	72	72	72	2	S	G	3	....	Same as 2.
8	Gn, 84 R	35	4	7	58	64	52	2	S	G	3	Few ...	Same as 3.
9	Gn, 84 R	40	4	7	54	56	52	2	S	G	3	Some ..	Same as 4.
10	Gn, 84 R	45	4	7	39	40	38	2	S	G	3	Many ..	Same as 5.
11	An, G	25	4	7	162	165	160	2	S	G	3½	....	Dry, but briquets showed slight moisture when finished.
12	An, G	30	4	7	165	168	162	2	S	G	3½	Few ...	Proper consistency.
13	An, G	35	4	7	108	110	106	2	S	G	3½	Some ..	Trifle moist.
14	An, G	40	4	7	75	84	66	2	S	G	3½	Many ..	Moist.
15	An, G	45	4	7	54	56	52	2	S	G	3½	...do ...	Very moist; would just hold its shape.
16	An, N	25	4	7	152	153	152	2	S	G	1½	....	Same as 1.
17	An, N	30	4	7	194	200	188	2	S	G	1½	....	Same as 11.
18	An, N	35	4	7	204	212	197	2	S	G	1½	Few ...	Same as 12.
19	An, N	40	4	7	134	148	120	2	S	G	1½	Some ..	Same as 3.
20	An, N	45	4	7	79	86	73	2	S	G	1½	Many ..	Same as 4.
21	Hn, 26s	25	4	7	226	236	216	2	S	G	7	....	Same as 2.
22	Hn, 26s	30	4	7	176	186	166	2	S	G	7	Few ...	Same as 3.
23	Hn, 26s	35	4	7	99	104	95	2	S	G	7	Many ..	Same as 4.
24	Hn, 26s	40	4	7	56	57	56	2	S	G	7	...do ...	Same as 5.
25	Hn, 26s	45	4	7	35	.....	.....	1	S	G	7	....	Would nearly flow when at rest; would readily flow when jarred.

SERIES 51*a*.—*Variations in consistency of mortar*—Continued.

TABLE 5.—NEAT NATURAL CEMENT, THREE BRANDS.

Reference.	Cement.	Water (per cent of dry ingredients).	Date made (December, 1893).	Age.	Tensile strength.				Molder.	Tank.	Time in molds (hours).
					Mean.	Highest.	Lowest.	Number averaged.			
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*
				Days.	*Lbs.*	*Lbs.*	*Lbs.*				
1	Gn, 83R	25	5	28	189	201	177	2	S	G	4
2	Gn, 83R	30	5	28	244	260	228	2	S	G	4
3	Gn, 83R	35	5	28	211	216	206	2	S	G	4
4	Gn, 83R	40	5	28	182	192	172	2	S	G	4
5	Gn, 83R	45	5	28	135	140	130	2	S	G	4
6	Gn, 84R	25	5	28	149	159	140	2	S	G	3
7	Gn, 84R	30	5	28	168	178	158	2	S	G	3
8	Gn, 84R	35	5	28	114	116	112	2	S	G	3
9	Gn, 84R	40	5	28	107	108	107	2	S	G	3
10	Gn, 84R	45	5	28	108	110	106	2	S	G	3
11	An, G	25	5	28	210	216	205	2	S	G	3¼
12	An, G	30	5	28	228	237	220	2	S	G	3¼
13	An, G	35	5	28	165	171	160	2	S	G	3¼
14	An, G	40	5	28	102	111	93	2	S	G	3¼
15	An, G	45	5	28	80	84	77	2	S	G	3¼
16	An, N	25	5	28	173	180	166	2	S	G	1¾
17	An, N	30	5	28	286	289	283	2	S	G	1¾
18	An, N	35	5	28	254	268	240	2	S	G	1¾
19	An, N	40	5	28	208	212	204	2	S	G	1¾
20	An, N	45	5	28	150	151	149	2	S	G	1¾
21	Hn, 26s	25	5	28	333	342	324	2	S	G	10
22	Hn, 26s	30	5	28	309	318	301	2	S	G	10
23	Hn, 26s	35	5	28	217	238	196	2	S	G	10
24	Hn, 26s	40	5	28	121	129	113	2	S	G	10
25	Hn, 26s	45	5	28	89	90	89	2	S	G	10

See corresponding numbers, Table 4.

SERIES 51*b*.—*Variations in temperatures of immersing tanks.*

TABLE 1.—NEAT NATURAL CEMENT.

[Brand Ln, sample 31s.]

Reference.	Water (per cent of dry ingredients).	Immersed.				Date made.	Age.	Tensile strength.				Molder.	Time in molds (hours).
		Tank.	Temperature (degrees F.).										
			Mean.	Highest.	Lowest.			Mean.	Highest.	Lowest.	Number averaged.		
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*		*k*	*l*	*m*
						1893.		*Lbs.*	*Lbs.*	*Lbs.*			
*1	30	*a*	79	82	78	12, 28	1 day...	109	120	92	5	S	1
*2	30	*k*	72	74	70	12, 28	1 day...	109	116	100	5	S	1
*3	30	*c*	62	62	62	12, 28	1 day...	120	136	108	5	S	1
*4	30	*f*	53	54	52	12, 28	1 day...	124	137	111	5	S	1
*5	30	*g*	41	43	40	12, 28	1 day...	143	152	134	5	S	1
6	30	*a*	80	85	72	12, 28	7 days..	186	203	165	5	S	1
7	30	*k*	70	74	67	12, 28	7 days..	193	209	167	5	S	1
8	30	*c*	60	62	57	12, 28	7 days..	183	187	177	5	S	1
9	30	*f*	50	52	47	12, 28	7 days..	201	221	180	5	S	1
10	30	*g*	40	42	35	12, 28	7 days..	204	213	198	5	S	1
						1894.							
11	30	*a*	80	84	72	1, 3	14 days.	245	251	236	5	S	1½
12	30	*k*	70	75	65	1, 3	14 days.	229	242	219	5	S	1½
13	30	*c*	60	62	58	1, 3	14 days.	204	217	192	5	S	1½
14	30	*f*	50	51	49	1, 3	14 days.	203	220	186	5	S	1½
15	30	*g*	40	42	37	1, 3	14 days.	184	194	176	5	S	1½
†16	30	*a*	80	84	72	1, 2, 3	28 days.	303	380	260	10	S	1½
†17	30	*k*	70	75	65	1, 2, 3	28 days.	281	310	245	10	S	1½
†18	30	*c*	60	62	58	1, 2, 3	28 days.	254	287	224	10	S	1½
†19	30	*f*	50	52	49	1, 2, 3	28 days.	245	277	218	10	S	1½
†20	30	*g*	40	42	37	1, 2, 3	28 days.	221	261	200	10	S	1½
21	30	*a*	80	84	72	1, 2	2 mos...	429	459	380	5	S	1½
22	30	*k*	70	75	65	1, 2	2 mos...	382	406	371	5	S	1½
23	30	*c*	60	62	58	1, 2	2 mos...	348	381	327	5	S	1½
24	30	*f*	50	52	49	1, 2	2 mos...	292	316	265	5	S	1½
25	30	*g*	40	42	37	1, 2	2 mos...	261	273	240	5	S	1½

* Immersed after 1 hour.

†Each result is the mean of 2 half sets made different days; 5 of each 10 immersed from 1½ to 7½ hours after made, other 5 after 24 hours, as usual.

TABLE 2.—NEAT NATURAL CEMENT.

[Brand An, sample G. Numbered diagonally.]

						1894							
1	30	*a*	80	83	76	2, 8	7 days..	177	206	160	5	S	1½
2	30	*k*	70	75	67	2, 8	7 days..	180	184	175	5	S	1½
3	30	*c*	60	62	58	2, 8	7 days..	186	204	170	5	S	1½
4	30	*f*	50	51	48	2, 8	7 days..	181	203	164	5	S	1½
5	30	*g*	40	42	37	2, 8	7 days..	186	198	168	5	S	1½
6	30	*a*	80	85	75	2, 8	14 days.	250	275	235	5	S	1½
7	30	*k*	70	76	67	2, 8	14 days.	227	240	215	5	S	1½
8	30	*c*	60	62	58	2, 8	14 days.	206	235	190	5	S	1½
9	30	*f*	50	51	48	2, 8	14 days.	179	195	170	5	S	1½
10	30	*g*	40	42	37	2, 8	14 days.	189	205	165	5	S	1½
11	30	*a*	80	86	75	2, 17	28 days.	249	260	228	5	S	1½
12	30	*k*	70	76	67	2, 17	28 days.	300	330	284	5	S	1½
13	30	*c*	60	62	58	2, 17	28 days.	239	260	220	5	S	1½
14	30	*f*	50	51	48	2, 17	28 days.	195	218	182	5	S	1½
15	30	*g*	40	42	37	2, 17	28 days.	207	224	172	5	S	1½
16	30	*a*	80	87	75	2, 17	2 mos...	351	378	329	5	S	1½
17	30	*k*	70	76	64	2, 17	2 mos...	386	400	375	5	S	1½
18	30	*c*	60	63	57	2, 17	2 mos...	328	340	316	5	S	1½
19	30	*f*	50	52	47	2, 17	2 mos...	285	289	282	5	S	1½
20	30	*g*	40	45	37	2, 17	2 mos...	243	274	224	5	S	1½

Series 51*b*.—*Variations in temperatures of immersing tanks*—**Continued.**

TABLE 3.—NATURAL CEMENT WITH ONE PART STANDARD SAND.

[Brand An, sample G. Numbered diagonally.]

Reference.	Water (per cent of dry ingredients).	Immersed.				Date made.	Age.	Tensile strength.				Molder.	Time in molds (hours).
		Tank.	Temperature (degrees F.).					Mean.	Highest.	Lowest.	Number averaged.		
			Mean.	Highest.	Lowest.								
	a	b	c	d	e	f	g	h	i	j	k	l	m
						1894.		Lbs.	Lbs.	Lbs.			
1	17.5	a	80	83	76	2, 6	7 days .	158	166	154	5	S	2¼
2	17.5	k	70	75	67	2, 6	7 days ..	154	162	146	5	S	2¼
3	17.5	c	60	61	58	2, 6	7 days ..	150	162	138	5	S	2¼
4	17.5	f	50	51	49	2, 6	7 days ..	140	154	126	5	S	2¼
5	17.5	g	40	42	37	2, 6	7 days ..	134	140	120	5	S	2¼
6	17.5	a	80	85	75	2, 6	14 days .	216	225	212	5	S	2¼
7	17.5	k	70	76	67	2, 6	14 days .	182	189	177	5	S	2¼
8	17.5	c	60	62	58	2, 6	14 days .	189	199	176	5	S	2¼
9	17.5	f	50	51	49	2, 6	14 days .	162	180	150	5	S	2¼
10	17.5	g	40	42	37	2, 6	14 days .	149	165	131	5	S	2¼
11	17.5	a	80	85	75	2, 9	28 days .	296	315	274	5	S	2¼
12	17.5	k	70	76	67	2, 9	28 days .	281	292	264	5	S	2¼
13	17.5	c	60	62	58	2, 9	28 days .	250	261	240	5	S	2¼
14	17.5	f	50	52	47	2, 9	28 days .	223	236	211	5	S	2¼
15	17.5	g	40	43	37	2, 9	28 days .	198	219	179	5	S	2¼
16	17.5	a	80	85	75	2. 9	2 mos...	403	465	352	5	S	2¼
17	17.5	k	70	76	67	2, 9	2 mos...	386	430	357	5	S	2¼
18	17.5	c	60	63	57	2, 9	2 mos...	337	349	323	5	S	2¼
19	17.5	f	50	52	47	2, 9	2 mos...	286	301	255	5	S	2¼
20	17.5	g	40	45	37	2, 9	2 mos...	251	258	244	5	S	2¼

TABLE 4.—NATURAL CEMENT WITH THREE PARTS STANDARD SAND.

[Brand An, sample G. Numbered diagonally.]

						1894.							
1	12.6	a	80	85	75	2, 7	14 days.	100	107	69	3	S	4
2	12.6	k	70	76	67	2, 7	14 days.	73	79	68	5	S	4
3	12.6	c	60	62	58	2, 7	14 days.	69	76	65	5	S	4
4	12.6	f	50	51	48	2, 7	14 days.	58	62	52	5	S	4
5	12.6	g	40	42	37	2. 7	14 days.	50	54	47	5	S	4
6	12.6	a	80	85	75	2, 7	28 days.	150	167	138	5	S	4
7	12.6	k	70	76	67	2, 7	28 days.	97	102	91	5	S	4
8	12.6	c	60	62	58	2, 7	28 days.	99	109	92	5	S	4
9	12.6	f	50	52	47	2, 7	28 days.	87	97	79	5	S	4
10	12.6	g	40	43	37	2, 7	28 days.	68	72	64	5	S	4
11	12.6	a	80	85	75	2, 10	28 days.	164	174	161	5	S	4
12	12.6	k	70	76	67	2, 10	28 days.	107	120	100	5	S	4
13	12.6	c	60	62	58	2, 10	28 days.	100	116	89	5	S	4
14	12.6	f	50	52	47	2, 10	28 days.	87	93	82	5	S	4
15	12.6	g	40	43	37	2, 10	28 days.	66	78	55	5	S	4
16	12.6	a	80	84	75	2, 10	2 mos...	231	252	217	5	S	4
17	12.6	k	70	76	67	2, 10	2 mos...	194	213	175	5	S	4
18	12.6	c	60	63	57	2, 10	2 mos...	147	153	141	5	S	4
19	12.6	f	50	52	47	2, 10	2 mos...	127	135	119	5	S	4
20	12.6	g	40	45	37	2, 10	2 mos...	104	123	90	5	S	4

SERIES 51*b*.—*Varying time in moist air before immersion*

TABLE 1.—GAIN OR LOSS IN STRENGTH BY IMMERSION.

[Natural cement. Numbered diagonally.]

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Date made (January, 1894).	Age.	Tensile strength.				Time in molds (hours).	Time in damp closet (hours).	Total time in moist air (hours).	Time immersed in tank, (days).	Gain (+) or loss (−) in water.	Tank.	Molder.
		Kind.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.							
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q
							Lbs.	Lbs.	Lbs.						Lbs.		
1	An, G	.....	0	30	30	20 hrs ..	151	165	139	5	1½	18½	20	....	....	....	S
2	An, G	.....	0	30	30	2 days ..	192	207	163	5	1½	46½	48	....	....	....	S
3	An, G	....	0	30	30	3 days ..	205	222	192	5	1½	70½	72	....	....	....	S
4	An, G	.....	0	30	30	4 days ..	218	226	210	5	1½	94½	96	....	....	....	S
5	An, G	.....	0	30	30	5 days ..	230	242	214	5	1½	118½	120	....	....	....	S
6	An, G	.....	0	30	30	7 days ..	147	160	130	5	1½	16½	18	6¼	−4	S	S
7	An, G	.....	0	30	30	7 days ..	160	174	138	5	1½	46½	48	5	−32	S	S
8	An, G	.....	0	30	30	7 days ..	177	186	160	5	1½	70½	72	4	−28	S	S
9	An, G	.....	0	30	30	7 days ..	191	222	176	5	1½	94½	96	3	−27	S	S
10	An, G	.....	0	30	30	7 days ..	192	198	176	5	1½	118½	120	2	−38	S	S
11	An, G	Std.	1	17.5	31	20 hrs ..	94	101	98	5	2	18	20	....	....	....	S
12	An, G	Std.	1	17.5	31	2 days ..	126	136	106	5	2	46	48	....	....	....	S
13	An, G	Std.	1	17.5	31	3 days ..	141	150	130	5	2	70	72	....	....	....	S
14	An, G	Std.	1	17.5	31	4 days ..	165	183	149	5	2	94	96	....	....	....	S
15	An, G	Std.	1	17.5	31	5 days ..	175	184	162	5	2	118	120	....	....	....	S
16	An, G	Std.	1	17.5	31	7 days ..	153	164	138	5	2	16	18	6¼	+59	S	S
17	An, G	Std.	1	17.5	31	7 days ..	158	162	152	5	2	46	48	5	+32	S	S
18	An, G	Std.	1	17.5	31	7 days ..	155	160	152	5	2	70	72	4	+14	S	S
19	An, G	Std.	1	17.5	31	7 days ..	165	180	154	5	2	94	96	3	00	S	S
20	An, G	Std.	1	17.5	31	7 days ..	169	184	156	5	2	118	120	2	−6	S	S

SERIES 51*c*.—*Varying time in moist air before immersion.*

TABLE 2.—NATURAL CEMENT.

Reference.	Cement.	Sand.		Water (per cent of dry ingredients.)	Date made (January, 1894).	Age (days).	Tensile strength.				Time in molds (hours).	Time in damp closet (hours).	Total time in moist air (hours).	Time in tank (days).	Tank.	Molder.
		Kind.	Parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.						
	a	b	c	d	e	f	g	h	i	j	k	l	m	n	q	p
							Lbs.	Lbs.	Lbs.							
1	An, G	......	0	30	17	7	168	184	160	10	1½	10½	12	6½	S	S
2	An, G	......	0	30	17	7	181	192	168	10	1½	22½	24	6	S	S
3	An, G	......	0	30	17	7	194	212	174	10	1½	46½	48	5	S	S
4	An, G	......	0	30	17	7	185	208	161	10	1½	70½	72	4	S	S
5	An, G	......	0	30	17	7	238	252	230	10	1½	166½	168	0	S	S
*6	An, G	......	0	30	18	28	200	233	178	10	1½	10½	12	27½	S	S
*7	An, G	......	0	30	18	28	210	230	198	10	1½	22½	24	27	S	S
*8	An, G	......	0	30	18	28	224	256	196	10	1½	46½	48	26	S	S
*9	An, G	......	0	30	18	28	241	266	222	10	1½	70½	72	25	S	S
*10	An, G	......	0	30	18	28	243	271	208	10	1½	166½	168	21	S	S
11	An, G	Std.	1	17.5	11	7	108	118	100	10	2	10	12	6½	S	S
12	An, G	Std.	1	17.5	11	7	137	151	126	10	2	22	24	6	S	S
13	An, G	Std.	1	17.5	11	7	141	150	136	10	2	46	48	5	S	S
14	An, G	Std.	1	17.5	11	7	157	184	138	10	2	70	72	4	S	S
†15	An, G	Std.	1	17.5	11	7	160	173	150	10	2	166	168	......	S	S
16	An, G	Std.	1	17.5	16	28	278	310	258	10	2	10	12	127½	S	S
17	An, G	Std.	1	17.5	16	28	283	298	262	10	2	22	24	27	S	S
18	An, G	Std.	1	17.5	16	28	297	312	282	10	2	46	48	26	S	S
19	An, G	Std.	1	17.5	16	28	297	338	276	10	2	70	72	25	S	S
20	An, G	Std.	1	17.5	16	28	301	332	282	10	2	166	168	21	S	S
‡21	An, G	Std.	3	12.6	19	28	120	154	102	10	4	8	12	27½	S	S
‡22	An, G	Std.	3	12.6	19	28	130	156	106	10	4	20	24	27	S	S
‡23	An, G	Std.	3	12.6	19	28	137	152	124	10	4	44	48	26	S	S
‡24	An, G	Std.	3	12.6	19	28	139	162	116	10	4	68	72	25	S	S
‡25	An, G	Std.	3	12.6	19	28	152	176	140	10	4	164	168	21	S	S

* Numbered diagonally. † Immersed for 1½ hour at end of 7 days. ‡ Numbered diagonally.

SERIES 51*d*.—*Variations in exposure of briquets before immersion.*

[Natural cement. Briquets numbered diagonally.]

Reference.	Cement.	Sand.		Water (per cent of dry ingredients).	Date made (January, 1894).	Age (days).	Tensile strength.				Time in molds (hours).	Total time in dry air (days).	Total time in moist air (days).	Total time in water (days).	Tank.	Molder.
		Kind and fineness.	Number of parts to 1 of cement.				Mean.	Highest.	Lowest.	Number averaged.						
	a	*b*	*c*	*d*	*e*	*f*	*g*	*h*	*i*	*j*	*k*	*l*	*m*	*n*	*o*	*p*
							Lbs.	*Lbs.*	*Lbs.*							
1	An, G	....	0	30	20	7	168	182	156	10	1½	1	......	6	S	S
2	An, G	....	0	30	20	7	181	196	172	10	1½	....	1	6	S	S
*3	An, G	....	0	30	20	7	121	127	113	5	1½	....	......	7	S	S
4	An, G	....	0	30	20	28	180	208	141	10	1½	1	......	27	S	S
5	An, G	....	0	30	20	28	195	213	182	10	1½	....	1	27	S	S
*6	An, G	....	0	30	20	28	145	158	139	5	1½	....	......	28	S	S
7	An, G	Std.20-30	1	17.5	22	7	162	170	140	10	2	1	......	6	S	S
8	An, G	Std,20-30	1	17.5	22	7	152	164	139	10	2	....	1	6	S	S
*9	An, G	Std.20-30	1	17.5	22	7	98	101	93	5	2	....	......	7	S	S
10	An, G	Std,20-30	1	17.5	22	28	224	256	199	10	2	1	......	27	S	S
11	An, G	Std,20-30	1	17.5	22	28	250	272	232	10	2	....	1	27	S	S
*12	An, G	Std,20-30	1	17.5	22	28	206	224	180	5	2	....	......	28	S	S
13	An, G	Std,20-20	3	12.6	23	7	57	66	52	10	4	1	......	6	S	S
14	An, G	Std,20-30	3	12.6	23	7	48	52	36	10	4	....	1	6	S	S
†15	An, G	Std,20-30	3	12.6	23	7	20	23	16	4	20	....	......	7	S	S
16	An, G	Std,20-30	3	12.6	23	28	140	159	131	10	4	1	......	27	S	S
17	An, G	Std,20-30	3	12.6	23	28	155	176	132	10	4	....	1	27	S	S
‡18	An, G	Std.20-30	3	12.6	23	28	117	133	110	6	20	....	......	28	S	S

* Scaled on face. †Scaled on face; quite soft when broken. ‡ Crumbled on face.

REPORT BY MR. F. H. REED, ASSISTANT ENGINEER, ON QUARRY FROM WHICH FACE STONE FOR 800-FOOT LOCK WERE OBTAINED.

UNITED STATES ENGINEER OFFICE,
Sault Ste. Marie, Mich., May 17, 1894.

SIR: I have the honor, in accordance with your directions, to make the following special report on the stone quarry at Kelleys Island, used by Hughes Bros. & Bangs, for obtaining face stone for the 800-foot lock, under their contract dated February 9, 1891:

No agent of the United States having been stationed at that portion of the work during its progress, the records at this office afford but meager information on this subject.

The following report, therefore, is compiled from the records of this office; from the notes and observations of Assistant Engineer E. S. Wheeler while inspecting that quarry; from the geological survey of Ohio, to which State this island belongs, and very largely from information obtained from Hughes Bros. & Bangs, who very kindly offered to give any information on the subject at their disposal.

Kelleys Island contains apparently about 5 square miles, its average dimensions being about 2½ miles long and 2 miles wide, with a distance of less than 4 miles between any two points on it. It is situated near the head of Lake Erie, about 10 miles from Sandusky, and directly north of it. The shortest sailing distance from it to Detroit appears to be about 64 miles, according to the lake survey charts; from it to Sault Ste. Marie, 410 miles.

The surface of the island is comparatively level, being about 15 feet above the level of the lake, except at the northern portion of it, which is the most elevated, and where a small local summit rises to a height of 60 feet above the lake level.

The entire island is composed of Corniferous limestone, as it lies in the line of the belt of outcrop of this formation, which passes northward through Columbus, Delaware, and Sandusky.

Only the lower or Columbus division of the Corniferous limestone is shown, the upper or Sandusky limestone having been entirely removed.

On the small summit previously mentioned there is a fine display of glacial markings deserving more than passing notice, from the fact that they are inscribed on the vertical as well as horizontal surfaces.

The limestone on Kelleys Island is rich in fossils, and furnishes a large number of the characteristic ones of the Corniferous group, many being of large dimensions.

In its vicinity it is perhaps only exceeded in the quantity and size of its fossils by Middle Island, which lies within Canadian territory, contains about 70 acres, rises but little above the level of the lake, and is of the same formation. On this island the observer seems to be standing on an ancient coral reef, containing a large number of species, many of which are of gigantic dimensions. Some of these grew in dome-shaped masses, like the Astreas and Meandrinas of our present tropical seas.

Specimens of Cyanthophyllum rugosum, Eridophyllum, and Strombodes 10 and even 12 feet in diameter have been discovered.

All of the islands of Lake Erie west of the two mentioned, comprising Put-in-Bay, North and Middle Bass, Rattlesnake, and Green islands are composed of the water-lime group.

At Kelleys Island the base of the Upper Helderberg series has dropped to the water's edge or a little below it. From a reef 8 or 9 feet below the surface of the lake unmistakable blocks of the Lower Helderberg limestone have been brought up.

The bottom of the quarries is in the flinty courses, that also constitute the floor of the Marblehead quarry section. This is followed by 9 feet of stone, the "bottom rock" of the quarrymen, quarried to be burned into lime; 6 feet of building stone; 9 feet of "cap rock," used for flux and pier stone, surmounted by 4 feet of extra cap, so called, which is a blue, highly fossiliferous but very thin-bedded, limestone. The last section is probably the lowest portion of the Sandusky section of the Upper Helderberg limestone. In tabular form the quarry section may be arranged as follows:

	Feet.
Extra cap rock, blue and thin-bedded limestone	4
Cap rock, flux, and pier stone	9
Bottom rock:	
Building stone	6
Used for lime burning	9
Flint course	0
Interval, not seen	15
Water of Lake Erie	0
Lower Helderberg limestone beneath surface	0

This, without exception, is the order and character of the sections on the island.

Thus it is seen that between 20 and 30 feet of the Upper Heldeberg limestone are commonly quarried here. These may be divided into two quite distinct and well-bounded sections, the upper one of which is a very pure limestone, averaging 90 per cent of calcite, and the lower one of which carries a much larger proportion of magnesia.

The lower division is preferred by the lime producers of this region, as it makes a more desirable lime for general use, is quarried in larger blocks, and is more easily burned. The face stone were obtained from this division.

The quarry leased by Hughes Bros. & Bangs for furnishing the face stones for the 800-foot lock was known as the "block stone" or "south" quarry. It was owned by Norman Kelley until about 1891, when it passed into the hands of the Kelley Island Lime and Transport Company. It was situated about 1¼ miles from the "north" quarry (on the other side of the island) and about 4¼ miles north of the Marblehead quarries (on the main land), from which two quarries the face stone for the lock of 1881 were obtained. According to the terms of the lease Hughes Bros. & Bangs worked the quarry with their own plant, methods, and labor, paying a royalty per cubic yard to the quarry owners for it, under the condition that the owners at all times should keep the quarry free from the spawls and rubbish incident to quarrying, The entire site of the quarry actually used was already stripped, the cap rock having long been removed for lime, flux, pier, and small building stone.

The height of the ledge quarried for the face stone varied from 6 feet at the west end to 12 feet at the east end of the quarry face. Underneath this ledge was the flint bed mentioned in the preceding table.

The quarry face was less than 500 feet in length. No horizontal seams of any consequence appeared, although open vertical seams perpendicular to the face of quarry and running in parallel lines at distances varying from 12 to 86 feet apart were encountered during the whole progress of the work.

At the close of the work all the rock stripped (that is, by the removal of cap stone, etc.) was quarried, the contractors having worked back into the quarry about 500 feet.

The plant used consisted of 1 blacksmith shop, office, tool house, 1 boarding house, 9 derricks, 4 Wardwell channelers, 5 Ingersoll-Sergeant gadding machines, 8 drills of the same make, 4 boilers, 6 cars, 3,000 feet of track for same, apparatus for supplying water, and the usual amount of small tools required in work of this kind.

The blacksmith shop, office, and tool house were in a one-story building 16 by 48 feet, constructed of rough lumber; the blacksmith shop containing two forges.

The boarding house was of similar construction, 18 by 40 feet, two stories in height.

The derricks were distribued as follows: One on the dock, 2 in the scabbling yard (adjacent to the quarry), and 6 at the quarry. The derrick on the dock was operated by a double drum engine. The remaining derricks had steam hoist only, a double-drum Lidgerwood engine (non-portable style) being assigned to each set of 2.

The 4 Wardwell channeling machines were of the double-gang type (that, is cutting on both sides at the same time), and were made at Rutland, Vt. They were of special pattern, being designed to cut channels 6 feet 10 inches apart.

Each machine weighed about 5 tons (shipping weight, with all the fixtures, being about 8 tons), was 10 feet in length, was furnished with a horizontal steel boiler of 6-horse power, usually carrying about 80 pounds of steam, and was supplied with 60 feet of steel track, the rail weighing 60 pounds to the yard. Each also was locomotive, cut while moving in either direction, could be reversed without stopping, and either or both sides operated as occasion demanded.

The feed was automatic, feeding forward on the track a half inch at every stroke, or about 6 feet per minute, each side striking about 150 blows per minute.

The depth of the channel was increased about one-half inch each time the machine passed over it. The width of the channel cut was 1¼ inches.

The 5 gadders were of standard size and were used for drilling horizontally. Size of hole drilled was 1¼ inches. The drills employed were of the "C" size.

Of the 8 drills, 4 were of the "C" size and 4 of the "A" or "Baby" size.

The "C" size was used for top drilling. Size of hole drilled was 1¼ inches.

The "A" size was used for the lighter work of trimming, subdividing, etc., where the plug and feather was made use of. Size of hole drilled was 1 inch.

The derricks, gadders, and drills were supplied with steam by 4 boilers, situated as follows: One at dock, 1 at scabbling yard, and 2 at quarry.

The cars used were all flat, and capable of safely sustaining 2 of the ordinary headers or stretchers in the rough, the volume of each being approximately 50 cubic feet.

The distance from the quarry to the dock was about 1,500 feet. For this about 3,000 feet of track was required, a single line with the necessary branches and switches at each end being used. The weight of rail was 30 pounds per yard.

The track was built up at the quarry so as to render it slightly down grade all the way towards the dock, and by this means but 2 horses were needed for transportation.

The dock (a crib one) was 150 feet long and 60 feet across its face, where the depth of water was 12 feet. The water along its sides was too shallow to admit of vessels loading there. The dock was not built by Hughes Bros. & Bangs, having been built previous to their operations on the island.

The apparatus for supplying water to the quarry consisted of a small duplex Worthington pump of 2-inch suction, situated on the dock, by which water was conveyed through a 1¼-inch pipe line to a tank of 4,000 gallons capacity, near the quarry. Thence water was conveyed by pipe line and hose to the boilers, drills, and channelers, where the channels were kept well flooded while the machines were working. The tank was placed on a trestle about 20 feet above the quarry.

The general plan of quarrying was as follows: Channels parallel to the quarry face were first cut to the full depth of the quarry at the proper distance between the open vertical quarry seams before mentioned.

Lines of horizontal holes were then drilled along the face, each line of holes being at the proper distance to give the required thickness of stone desired, the lowest line being at the bottom of the quarry. The holes of each line were about 3 feet apart. Vertical holes were then drilled between the channel and face about 2½ feet apart at such distances as the size of stone required.

The holes were then elongated in the direction of the required fracture. This was done with a drill-shaped tool, known as a reamer, a little larger than the hole drilled, driven down by a sledge.

The whole mass of stone was then loosened from the bottom of quarry by simultaneously discharging the lower line of horizontal holes; after which each set of vertical holes was discharged. The remainder of the horizontal holes were then discharged as fast as occasion demanded, the stones removed, trimmed by the plug and feather, hammer, etc., scabbled if required, and sent to dock for transportation.

The explosive used was the common black blasting powder of the "B" grade. A battery was used to discharge it. In loading, after the cartridge rested on the bottom the hole was plugged about a foot above the top of cartridge, thus forming an air chamber. That portion above the plug was then filled and tamped in the ordinary manner. In each case the depth of the hole was about a foot less than the height of the ledge or the distance between the parallel channel faces.

The charge of powder per hole was usually about a half pound.

Such was the method of quarrying usually followed; varied, of course, as necessity or convenience demanded.

Each dimension of the rough stone was at least 4 inches greater than the corresponding dimension of the same stone after being cut.

The total amount of rough stone transported for the 800-foot lock was 113 vessel loads, containing 15,204 pieces, or by a very close approximation about 27,000 cubic yards. Of these about 629 pieces (1,200 cubic yards approximately) remained on hand at the close of the work, being culls and duplicates. The sizes of the stone quarried varied from 11 to 183 cubic feet, the average being about 50 cubic feet.

The character of the work varied but little during the whole progress of the work. Several different channel faces were worked at the same time. But two channeling machines were employed the first season, the other two being subsequently purchased.

Quite a large portion of the employés were Italians.

The progress of the work may be summarized as follows: On April 7, 1891, the work of grading and building tracks, erecting derricks, etc., began; April 17, began fitting out the machinery; April 20, the first channeling machines started.

Work continued until November 19, when operations ceased for the winter.

The work of refitting was resumed for the season of 1892, March 21. The channeling machine and full force of men began April 1. Work was continued without interruption until September 25, when the work closed for the season.

On March 29, 1893, operations were resumed with full force and continued until October 10, when, the stone being all quarried, the work at the quarry was closed.

The number of pieces transported from there each year is shown as follows:

Year.	Number of vessel loads.	Number of pieces.
1891	14	1,912
1892	56	7,570
1893	43	5,722
Total	113	15,204

About 900 pieces of the stone quarried during the latter part of the first season were reserved for shipment until the season following. About 100 pieces of these, however, were broken by frost during the ensuing winter, and were thus rendered unfit for use.

The vessels used for conveying the stone from Kelleys Island to Sault Ste. Marie were usually second class and of small size. They were mostly sailing vessels, although a few small steam barges with one vessel in tow were engaged in the trade. The average registered tonnage of the steam barges employed would be about 270 tons; that of the sailing vessels about 295 tons.

Vessels with large hatches were best adapted to this trade, the loading and unloading of large pieces being much facilitated thereby. Hughes Bros. & Bangs let this portion of their work by contract to J. M. Jones, of Detroit, at the rate of $1.80 per cubic yard. Although in all cases it is not known what arrangements Mr. Jones made with the vessel owners, yet in some instances it is known that he paid $1.60 per cubic yard. The weight of the stone was 157.16 pounds per cubic foot.

Every cargo reached Sault Ste. Marie safely.

The channelers, gadders, and drills each required 1 operator and 1 assistant.

The channelers were operated thirteen hours per day, the remainder of the plant ten hours.

The following table gives the average daily force employed during the progress of the work:

Year.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1891	....	27	32	60	75	94	91	68
1892	44	116	124	124	131	127	....	....
1893	90	124	118	99	82	68	55	....

The common or unskilled labor was employed at $1.50 per day.

Very respectfully, your obedient servant,

F. H. Reed,
Assistant Engineer.

Mr. E. S. Wheeler,
Assistant Engineer, etc.

M M 4.

IMPROVEMENT OF HAY LAKE CHANNEL, ST. MARYS RIVER, MICHIGAN.

Before improvements were commenced the channel through Hay Lake was restricted in depth at Sugar Island Rapids and at Middle Neebish. At these two places a maximum draft of but 8 or 9 feet could be carried if a very irregular course was taken, and practically vessels drawing more than 6 feet of water would not attempt the passage. In addition to the places above mentioned, there were some shoals in Hay Lake requiring removal to make the channel available for vessels navigating St. Marys River.

The original estimates for this improvement were based upon a project for a channel 300 feet wide and 17 feet deep, leaving the present navigable channel of St. Marys River at Sugar Island Rapids (about 2½ miles below the canal) through these into Hay Lake, and then, by way of Middle Neebish, rejoining the present navigable channel at the foot of Sugar Island, thus saving a distance of 11 miles and obtaining a route which can be so marked by lights as to be navigable by night, a condition impracticable with the present channel except by the use of many lights.

The estimated cost of this project was $2,127,292. The project was subsequently modified to increase the navigable depth to 20 feet, the estimated cost being $2,659,115, subject to change, however, in case unexpected difficulties are developed during the progress of the work.

Prior to June 30, 1890, $975,000 had at various times been appropriated for the work. The river and harbor act of September 19, 1890, appropriated an additional $400,000 for continuing the improvement with the provision—

> That such contracts as may be desirable may be entered into by the Secretary of War for materials and labor for the entire work, or any part of the same, to be paid for as appropriations may from time to time be made by law.

The sundry civil act of March 3, 1891, appropriated $300,000 for continuing the improvement during the fiscal year ending June 30, 1892; the sundry civil act of August 5, 1892, appropriated $115,000 for continuing the improvement during the fiscal year ending June 30, 1893; the sundry civil act of March 3, 1893, appropriated $225,000 for continuing the improvement during the fiscal year ending June 30, 1894. The total amount appropriated to date, therefore, is $2,015,000, with authority to contract for all or any part of the work.

EXCAVATIONS UNDER FORMER CONTRACTS.

Prior to the beginning of work under the contracts now in force, excavation had been carried on at Middle Neebish with the following results:

Amount excavated.

	Cubic yards (bank measure).
Experimental work, 1882-1886	36, 113
John Hickler, contract of February 28, 1883	201, 080
John Hickler, contract of September 5, 1884	59, 411
Hickler & Green, contract of May 18, 1885	65, 128
Hickler & Green, contract of December 24, 1886	79, 033. 92
C. F. & H. T. Dunbar, contract of October 30, 1888	171, 141. 25
Total	611, 907. 17

In addition, 15,200 cubic yards, scow measure, were removed from the channel at Sugar Island Rapids between 1886 and 1889 and put in the cofferdam of the 800-foot lock in St. Marys Falls Canal. These amounts are exclusive of excavation outside of channel lines or below grade.

This work left the channel in the condition shown by the map facing page 2759 of the Annual Report of the Chief of Engineers for 1891.

Under the present project the first section was completed in October, 1892.

CONTRACTS.

List of contracts in force during fiscal year ending June 30, 1894.

Contractor.	For—	Entered into—	Remarks.
Dunbar & Sullivan	Excavation section 2	Feb. 6, 1891	In force.
Carkin, Stickney & Cram	Excavation section 3	....do	Closed November, 1893.
Do	Excavation section 4	....do	Closed August, 1893.
C. F. & H. T. Dunbar	Excavation section 5	....do	In force.
Carkin, Stickney & Cram	Excavation section 6	....do	Do.
Hickler Bros	Dredging plant	Aug. 18, 1892	Closed December, 1893.
Do	Wood and coal	Apr. 27, 1893	Do.
James Strachan	Machine work	....do	Do.
Ferguson Hardware Co	Hardware, ship chandlery, etc.	....do	Do.
Prenzlauer Bros	Groceries	....do	Do.
Andrew Hotton	Meats	....do	Do.

PLANT.

The principal plant on this work owned by the United States is 1 tug, 1 quarter boat, 10 row boats, and 1 sounding raft, all of which were kept in good repair.

The plant used by the contractors during the year was as follows: Eleven dredges, 12 tugs, 1 drill boat, 2 derrick screws, 24 dump scows, 6 flat scows, 1 machine shop on shore, 2 floating machine shops, 2 carpenter shops, and 3 sets docking ways.

One dredge and 3 tugs were rebuilt and 3 new dump scows were built.

EXCAVATION UNDER CONTRACTS STILL IN FORCE.

During the fiscal year excavation has been carried on under five contracts entered into February 6, 1891. Each of these contracts covers one of the sections into which the work has been divided, as shown on the map appended to my annual report for fiscal year ending June 30, 1892. A depth of 20 feet was required, except where bed rock occurred, where a depth of 21 feet was called for in order that a 20-foot navigation might be established. At the close of the fiscal year the condition of the work on the unfinished sections was as follows:

Second section.—The material to be excavated consisted of about 344,000 cubic yards of sand, gravel, bowlders, hardpan, and sandstone bed rock in unknown proportions, and some blasting was necessary. On bed rock the depth of 21 feet is required; elsewhere 20 feet, and the contract price is 57 cents per cubic yard, bank measure. The contractors, Messrs. Dunbar & Sullivan, began operations May 15, 1891. The total to June 30, 1894, of the estimates for excavation is 301,182 cubic yards, bank measure, of which 110,303 cubic yards were excavated during the fiscal year. The dredging on this section was completed on June 16. Some pieces of rock that were found by the raft bars to be above grade are yet to be removed. This work is being done by a diver. The original contract time for the completion of this work was November 30, 1893. This time was extended to June 30, 1894, and has been extended again to September 1, 1894.

Third section.—The material to be removed consisted of about 1,016,000 cubic yards of silt, sand, clay, and gravel. The depth of 20 feet was required, and the contract price was 14¾ cents per cubic yard, bank measure. The contractors, Messrs. Carkin, Stickney & Cram, began operations May 27, 1891, and completed the work October 31, 1893. The total of the estimates for excavation was 1,121,800.3 cubic yards, bank measure, of which 13,779 cubic yards were excavated during the fiscal year. Of the above total, 168,383.3 cubic yards were paid for at half price, the material having been excavated from between 20 and 21 foot grades.

On the lower 2,000 feet of this section a number of bowlders and small stones were found embedded in the clay. As the specifications only called for the removal of silt, sand, clay, and gravel, the contractors were paid $1,318 extra for the additional expense to them in removing these bowlders and stone.

Fourth section.—The material to be removed consisted of about 650,000 cubic feet of sand, clay, gravel, and bowlders. The depth of 20 feet was required, and the contract price was 13 cents per cubic yard, bank measure. The contractors, Messrs. Carkin, Stickney & Cram, began operations July 16, 1891, and completed the work July 21, 1893. The total of the estimates for excavation was 770,841 cubic yards, bank measure, of which 877 cubic yards were excavated during the fiscal year. Of the above total, 120,099.4 cubic yards were paid for at half price, the material having been excavated from between the 20 and 21 foot grades. The shoal off Nine Mile Point was included in the original contract for this section. The shoal was specified as being approximately 50 by 150 feet in area. This shoal was found to be 600 by 800 feet in area, the material, sand, bowlders, hardpan, and sandstone rock in situ. The contractors refused to excavate more than the amount comprised in area specified in contract. The United States removed the remainder of the shoal with a dredge hired, under contract with Hickler Bros., by the hour; 42,931 cubic yards were excavated at a cost of 58 cents per cubic yard. This dredged area has been swept; some bowlders and stones were found above grade. The cleaning up of this portion of the shoal will be done by a diving party.

Fifth section.—The material to be removed consisted of about 710,000 cubic yards of sand, clay, gravel, bowlders, and wood. The depth of 20 feet is required, and the contract price is 14 cents per cubic yard, bank measure. The contractors, C. F. and H. T. Dunbar, began operations June 6, 1891. The total to June 30, 1894, of the estimates for excavation is 503,221 cubic yards, bank measure, of which 93,807 cubic yards were excavated during the fiscal year. The original contract time for the completion of this section was November 30, 1893. The contract time was extended to June 30, 1894, and has been again extended to September 1, 1894. There remain three cuts 800 feet long to be dredged from the west bank at the upper end of section, also the removal of ridges which are above grade. Work was commenced on the dike on the west side.

Sixth section.—The material to be removed consisted of about 735,000 cubic yards of sand, clay, gravel, bowlders, and wood. The depth of 20 feet is required, and the contract price is 14¾ cents per cubic yard, bank measure. The contractors, Messrs. Carkin, Stickney & Cram, began operations on May 19, 1892. The total of the estimates for excavation to June 30, 1894, is 533,409 cubic yards, bank measure, of which 131,427 cubic yards were excavated during the fiscal year. The original contract time for the completion of this section was November 30, 1893. This time was extended to June 30, 1894, and has been extended again to July 31, 1894. The entire area comprised in the section has been dredged. The contractors are now cleaning out bowlders and ridges left above grade. The upper and lower dikes have been built, and the middle dike of stone and bowlders is within 2 feet of the water surface.

On the 7th of June the steamer *North West*, followed by the steamer *J. H. Wade*, passed up through the Hay Lake Channel. The passage was made without difficulty. The entire channel has been dredged to a depth of 20 or 21 feet, according to specifications, for a width of 300 feet throughout, except at one point in Little Rapids, where it is only 250 feet wide for a distance of about 800 feet. Sections 1, 3, and 4 have been cleaned up and the work accepted. Sections 2 and 6 are being cleaned up now and the dredging on section 5 is nearly completed.

The rapid increase of the number of boats adds largely to the danger of accidents during the night navigation of the Middle Neebish, and makes the project of widening the channel through the rock at that locality to 400 feet one of great importance.

Also that portion of the channel from cross-section 504 to 754, a distance of 2,500 feet, which was improved to a depth of 20 feet under contracts dated December 24, 1886, and October 30, 1888, should be deepened to 21 feet, thus making it uniform with all the rest of the rockwork.

Maps showing the completed work and the progress of the work under way are forwarded herewith.

DIKES.

In the original plan for improving Hay Lake Channel certain dikes were designed to prevent the lowering of the water in the pool below the locks when the channel was dredged through the islands to Hay Lake; likewise to prevent the lowering of the water in Hay Lake by the Middle Neebish Channel. Some of the dikes were to be built under the original contracts, and the United States has built some with a dredge hired by the hour. The exact results produced by work of this character can never be predicted and some additions and changes may be found necessary after the work is completed and opened to navigation.

The work has been under the local charge of Assistant Engineer E. S. Wheeler, with Assistant Engineer Joseph Ripley in immediate charge. The latter has been assisted by Assistant Engineers Benno Rohnert, F. C. Shenehon, C. Y. Dixon, Inspector L. P. Morrison, Clerk R. Common, and Draftsman Mangelsdorf.

The advantages of the improvement have been so frequently set forth in preceding reports, and are so universally admitted, that it is not deemed necessary to repeat them. It is an important part of the system for the improvement of the navigation of the Great Lakes.

The estimate for the work is $2,659,115, of which $2,015,000 has been appropriated, leaving $644,115 to be provided. If the $150,000, estimated in my annual report of June 30, 1893, for the payment of the various Government employés and contractors for the fiscal year ending June 30, 1895, be appropriated, no additional appropriation will be necessary in order to complete the present project.

Total expenditure to June 30, 1893	$1,455,163.43
Expended during fiscal year, exclusive of outstanding liabilities	214,777.01
Total expenditure to June 30, 1894	1,669,940.44

Hay Lake Channel is in the collection district of Superior, Mich. The nearest port of entry is Marquette, but Sault Ste. Marie is a subport. The nearest lighthouse is the beacon on the pier at the western end of St. Marys Falls Canal.

Money statement.

July 1, 1893, balance unexpended		$559,968.22
June 30, 1894, amount expended during fiscal year		214,777.01
July 1, 1894, balance unexpended		345,191.21
July 1, 1894, outstanding liabilities	$41,336.50	
July 1, 1894, amount covered by uncompleted contracts	83,087.00	
		124,423.50
July 1, 1894, balance available		220,767.71

Amount (estimated) required for completion of existing project	644,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Appropriations for improving Hay Lake Channel, Sault Ste. Marie River, Michigan.

August 2, 1882	$200,000
July 5, 1884	125,000
August 5, 1886	150,000
August 11, 1888	500,000
September 19, 1890	400,000
March 3, 1891 (sundry civil bill)	300,000
August 5, 1892 (sundry civil bill)	115,000
March 3, 1893 (sundry civil bill)	225,000
Total	2,015,00

M M 5.

IMPROVEMENT OF ST. CLAIR FLATS CANAL, MICHIGAN.

Before the construction of this canal St. Clair River emptied into Lake St. Clair through seven principal mouths or passes, the one ordinarily used by vessels being known as the South Channel, and having a minimum depth of a little less than 11 feet.

St. Clair Flats Canal was projected in 1866 with a view of obtaining a straight channel 13 feet deep and 300 feet wide across the flats east of the mouth of the channel, and the work was finished in 1871.

The channel is bounded on each side by a dike 7,221 feet long, or an aggregate of 14,442 feet, these dikes consisting of timber resting upon piles driven into the original bottom of the shoal, the crib pockets being filled with material dredged from the channel and the cribs backed with dredged material.

To maintain a channel bank a single row of sheet piling was driven along the channel face of the cribs previous to dredging, and the back or lake sides of the dikes were protected from wave action by shorter sheet piling.

In 1873 the channel was deepened to 16 feet by dredging for a width of 100 feet on each side of the axis of the canal, or a width of 200 feet in all, being thus limited by the fact that the single row of sheet piles intended for a depth of 13 feet had not sufficient penetration to admit of dredging to 16 feet for the full width of the canal, and was also insufficient to prevent leakage of the dike-filling through it into the channel.

The present project for the improvement of the canal contemplates driving a double row of sheet piling to a depth of 26 feet along the channel face of each dike, dredging the area between the dikes to a depth of 20 feet, continuing the channel above and below the canal to the same depth in river and lake, and rebuilding the decayed portions of the timber superstructure. It was considered sufficient to obtain a depth of 18 feet and to postpone obtaining a depth of 20 feet until the general project for a continuous depth of 20 feet along the entire water route shall have reached a more advanced stage. The estimated cost of obtaining these two depths is as follows:

For 18 feet	$365,000.00
For 20 feet	513,559.40

On June 30, 1893, the pile revetment along the channel face of each dike was completed, and a channel 18 feet in depth extended from the 18-foot curve in St. Clair River, about 900 feet above the canal, for the full width of the canal (about 300 feet), and throughout the entire length; thence gradually widening to 380 feet at a distance of 300 feet below the canal; thence with a width of 380 feet a further distance of 3,300 feet.

No work was done during the fiscal year and the condition remains as stated in previous paragraph.

That portion of the general project calling for a depth of 20 feet in the canal and the approaches has been provided for in the river and harbor act of July 13, 1892, for "Ship channel connecting the waters of the Great Lakes between Chicago, Duluth, and Buffalo."

The pile revetment along the channel face of the dikes having been completed, the rebuilding of the decayed portions of the timber superstructure constitutes the work yet to be done.

This timber has been in place some twenty-five years and is in a very bad condition. The amount necessary to rebuild the timber superstructure is estimated to be not less than $120,000; and this entire amount can be profitably expended during the fiscal year ending June 30, 1896. The necessity for this work is very urgent.

Total expenditure to June 30, 1893	$760,222.86
Expended during fiscal year	.60
Total expenditure to June 30, 1894	760,223.46

St. Clair Flats Canal is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. Two light-houses stand upon its banks.

Money statement.

July 1, 1893, balance unexpended	$4,587.14
June 30, 1894, amount expended during fiscal year	.60
July 1, 1894, balance unexpended	4,586.54
Amount (estimated) required for completion of existing project	120,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	120,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Appropriations for improving St. Clair Flats Canal, Michigan.

June 23, 1866	$80,000	June 18, 1878	$5,000
March 2, 1867	150,000	March 3, 1879	3,000
July 25, 1868	86,000	June 14, 1880	2,500
April 10, 1869	142,560	August 5, 1886	18,750
July 11, 1870	16,500	August 11, 1888	75,000
March 3, 1871	1,500	September 19, 1890	80,000
June 10, 1872	4,000		
March 3, 1873	100,000	Total	764,810

NOTE.—The appropriation of 1852, $20,000, and 1856, $45,000, are not taken account of for the reason that they did not enter into the improvement of St. Clair Flats Canal, the first having been expended in building a dredge and the second in dredging the South Pass. From March 3, 1881, the amounts allotted for operating and care of St. Clair Flats Canal are rendered separately.

M M 6.

OPERATING AND CARE OF ST. CLAIR FLATS CANAL, MICHIGAN.

The canal is in the immediate charge of a custodian, who reports any violations of canal regulations, and also acts as inspector whenever any work is in progress.

During October, 1893, the breaks made in the east and west dikes by the steamers *C. F. Beilman* and *Marina* were repaired at a cost of $233.56.

The material (principally sand) composing the dikes is held in place on the outside faces by a single row of sheet piling. The seas receding, after breaking over the dikes during storms, suck the sand through this piling to such an extent as to make large holes in the dikes, sometimes extending at least half way through. In the spring these holes are filled up with some material that the water will not move. Cedar bark has been found to be an excellent material for this purpose, and can be obtained cheaply in this locality. Five hundred cords of this bark were purchased and placed in the holes washed out by the storms. At those places along the dikes where the earth pressure is transmitted through the old work to the new pile revetment, this new revetment was tied by means of iron rods passing through the dike to piles in rear of the dike. Twenty-one such rods were placed in the dikes during the fiscal year.

During the fiscal year ending June 30, 1894, the ordinary current expenses of operating and care of the canal, such as salary of custodian, ordinary repairs to dikes, trimming willows, etc., exclusive of the amount named above, was $3,358.62.

The estimated cost of operating and care of canal for fiscal year ending June 30, 1895, is as follows:

Salary of custodian	$1,500
Current repairs and contingencies, which can neither be foreseen nor estimated for in detail, to include a fair proportion of the expenses of the office of the superintending engineer at Detroit	3,500
Total	5,000

All of which is provided for by indefinite appropriation (section 4 of the river and harbor act of June 5, 1884).

Total expenditure to June 30, 1893	$63,642.90
Expended during fiscal year (exclusive of outstanding liabilities)	3,586.18
Expenditure to June 30, 1894	67,229.08
Outstanding liabilities June 30, 1894	181.00
Total expenditure to June 30, 1894	67,410.08

St. Clair Flats is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. Two light-houses stand upon its banks.

Money statement.

Amount required for fiscal year ending June 30, 1895		$5,000.00
Balance remaining from allotment of preceding year	$1,938.82	
Outstanding liabilities, partly known and partly estimated	300.00	
		1,638.82
Additional allotment required for fiscal year ending June 30, 1895		3,361.18

Appropriations for operating and care of St. Clair Flats Canal, Michigan.

[Expended during fiscal year ending June 30.]

1882	$8,783.69	1890	$2,158.16
1883	5,668.87	1891	2,020.20
1884	2,532.15	1892	1,888.67
1885	4,906.59	1893	2,675.93
1886	9,539.11	1894	3,592.18
1887	1,819.53		
1888	1,510.00	Total	67,410.08
1889	20,315.00		

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite, applied to operating and care of St. Clair Flats Canal, Michigan, for the fiscal year ending June 30, 1894.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
1893.		*Part of month of July, 1893.*		
May 11 to June 23	2	David Watson	41 cords cedar bark, at $1.60 per cord	$65.60
July 17	3	Pay roll, July, 1893	1 carpenter, 8 days, at $3 per day	24.00
			2 laborers, 10 days, at $2 per day	20.00
6	4	A. Bower & Co	736 feet B. M. oak timber, at $40 per M feet.	29.44
			600 feet B. M. pine timber, at $30 per M feet.	18.00
		Month of August, 1893.		
Aug. 1	1	Pay roll, July, 1893	1 custodian	125.00
			1 oarsman, etc	50.00
July 3-22	2	David Watson	121 cords cedar bark, at $1.60 per cord	193.60
		Month of September, 1893.		
Sept. 1	1	Pay roll, August, 1893	1 custodian	125.00
			1 oarsman, etc	50.00
July 31 to Aug. 12	2	David Watson	133 cords cedar bark, at $1.60 per cord	212.80
Aug. 18	3	J. S. Nesbit	8 white oak piles, 288 linear feet, at 10 cents per linear foot.	28.80
Aug. 11 to Sept. 2	4	Peter Koenig	43 cords cedar bark, at $1.60 per cord	68.80
Aug. 31	5	Saml. F. Hodge & Co	23 tie rods with turn buckles, washers, and nuts, complete.	220.00
July 25	6	Michigan Bolt and Nut Works, by E. T. Gilbert, secretary and treasurer.	257 pounds bolts, assorted, at 2½ cents per pound.	6.42
Sept. 26	7	Pay roll, September, 1893	1 carpenter, 12 days, at $3 per day	36.00
			5 laborers, 50 days, at $2 per day	100.00
		Month of October, 1893.		
Oct. 2	1	Pay roll, September, 1893	1 custodian	125.00
			1 oarsman, etc	50.00
16	2	Pay roll, part September and part October, 1893.	1 carpenter, 11 days, at $3 per day	33.00
			3 laborers, 31 days, at $2 per day	62.00
Sept. 28	3	Dry Dock Engine Works, by A. McVittie, vice-president and treasurer.	666 pounds bolts and washers, at 7½ cents per pound.	49.96
			100 pounds spikes, at 4 cents per pound.	4.00

Itemized statement of expenditures incurred on account of appropriation for operating and care of canals and other works of navigation, indefinite, applied to operating and care of St. Clair Flats Canal, Michigan, etc.—Continued.

Date.	No. of voucher.	From whom purchased.	Articles.	Amount.
		Month of October, 1893—Continued.		
1893.				
Sept. 23	4	A. Bower & Co.	1,320 feet B. M. pine, at $35 per M	$46.20
			960 feet B. M. oak, at $40 per M	38.40
18–22	5	Peter Koenig	72 cords cedar bark, at $1.60 per cord	115.20
		Month of November, 1893.		
Nov. 1	1	Pay roll October, 1893	1 custodian	125.00
			1 oarsman, etc	50.00
Sept. 26 to Oct. 24	2	David Watson	46½ cords cedar bark, at $1.60 per cord	74.40
		Month of December, 1893.		
Dec. 1	1	Pay roll November, 1893	1 custodian	125.00
			1 oarsman, etc	50.00
		Month of January, 1894.		
1894.				
Jan. 2	1	Pay roll December, 1893	1 custodian	125.00
			1 oarsman, one-half month, at $50 per month.	25.00
		Month of February, 1894.		
31	1	W. H. Mott	Services as custodian, between Jan. 1 and 31, 1894 (both days inclusive), being 1 month.	125.00
		Month of March, 1894.		
Feb. 28	1	W. H. Mott	Services as custodian, between Feb. 1 and 28, 1894 (both days inclusive), being 1 month.	125.00
		Month of April, 1894.		
Mar. 31	1	W. H. Mott	Services as custodian between Mar. 1 and 31, 1894 (both days inclusive), being 1 month.	125.00
Apr. 16	2	Michigan Carbon Works, by W. H. Burtenshaw, secretary and treasurer.	3 tons (6,000 pounds) net homestead B. B. fertilizer, at $28.60 per ton.	85.80
12	3	H. D. Edwards & Co.	23½ pounds rope manila, at 8 cents per pound.	1.88
			4 double blocks, at $1.55 each	6.20
			$\frac{1}{12}$ dozen bolts, ring screws, ⅜-inch, at $2,80 per dozen, 23 cents; $\frac{1}{12}$ dozen bolts, ring screws, $\frac{7}{16}$-inch, at $3.20 per dozen, 27 cents; ⅙ dozen bolts, ring screws, ½-inch, at $3.60 per dozen, 60 cents; total, $1.10. Less discount 33⅓ per cent, 37 cents.	.73
		Month of May, 1894.		
Apr. 30	1 and 2	Pay roll, April, 1894	1 custodian, 1 month, at $125 per month	125.00
			1 oarsman, 1 month, at $50 per month	50.00
			6 laborers, 59 days, at $2 per day	118.00
23	3	H. D. Edwards & Co.	19½ pounds twine (binder), at 10 cents per pound.	1.95
		Month of June, 1894.		
May 31	1	Pay roll, May, 1894	1 custodian, 1 month, at $125 per month	125.00
			1 oarsman, 1 month, at $50 per month	50.00
		Month of July, 1894.		
July 2	1	Pay roll, June, 1894	1 custodian, 1 month, at $125 per month	125.00
			1 oarsman, 1 month, at $50 per month	50.00
			1 painter, 2 days, at $3 per day	6.00
				3,592.18

M M 7.

IMPROVEMENT OF GROSSEPOINT CHANNEL, MICHIGAN.

Between the lower end of St. Clair Flats and the deep water of Detroit River the only known obstruction to navigation is the large shoal off Grossepoint, known as Grossepoint Flats. At ordinary stages of water vessels drawing 16 feet can cross this obstruction, but when the water is as low as it has been during the last few years vessels drawing more than 15 feet can pass only with great care and difficulty.

The river and harbor act of August 11, 1888, appropriated $75,000 for "improving St. Clair Flats Ship Canal, * * * all or any portion of which may, in the discretion of the engineer, be expended in dredging Grossepoint Channel." The sum of $5,000 was consquently reserved from this appropriation for the removal of any small and well-defined obstruction that might be found at Grossepoint, as well as for making such surveys as might be necessary before making a definite project. A small shoal was removed in July, 1889, but no more such obstructions have since been found.

The condition of affairs was such that any increase of depth could only be obtained by dredging across a long shoal and, consequently, by the expenditure of a large sum of money.

Grossepoint Channel forms a part of the "ship channel connecting the waters of the Great Lakes between Chicago, Duluth, and Buffalo," which is provided for in the river and harbor act of July 13, 1892.

All information concerning the work at this point will be found in the report for improvement of ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo.

Grossepoint Channel is in the collection district of Detroit, Mich. Windmill Point Light-House and range lights are in close vicinity.

Money statement.

July 1, 1893, balance unexpended	$3,844.05
July 1, 1894, balance unexpended	3,844.05

The existing project for Grossepoint Channel is a part of the project for ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo. The requirements of sections 2 of river and harbor acts of 1866 and 1867 will be complied with in the report for last-named work.

M M 8.

IMPROVEMENT OF DETROIT RIVER, MICHIGAN.

Originally the channel at Limekiln Crossing, Detroit River, could not be depended upon for more than 13 feet of water, the ordinary depth being much affected by the direction of the wind. As originally projected in 1874 the improvement at this point was to consist of a curved channel 300 feet wide, with a uniform depth of 20 feet, and the original estimate was based upon this project.

In 1883, it was wisely determined to so modify the project as to secure a straight channel, the least width of which should be 300 feet, with a somewhat greater width at each end, utilizing the work already done.

In 1886 this was further modified to the end that the width of the channel should be increased to 400 feet by removing an additional 100

Chas. F. Walthers
. Balto., Md. Eng. 58 3.

feet from the western (American) side; in 1888 a further additional width of 40 feet on the western side was authorized, as the lowest bid under the final appropriation was so low that the money available was sufficient to pay for the increased excavation.

The estimated cost of a 400-foot channel was $1,374,500. The total amount expended up to June 30, 1891, was $702,122.04, and the result has been a channel 440 feet in width, thus accomplishing one-tenth more work than was estimated for at a cost of but little more than half the estimate. Gratifying as this is, the benefit to commerce is far beyond the amount of the original estimate, and since the excavation is through rock the improvement will be permanent.

The present project contemplates the removal of such shoals in Detroit River between the city of Detroit and Lake Erie as obstruct navigation.

No work has been in progress during the fiscal year. The only work done to date under the present project was an examination of the channel from Ballards Reef to the head of Limekiln Crossing.

This work was done with a sweeping scow, and an area of 2⅛ miles long and from 800 to 1,000 feet wide was swept, the longitudinal axis of this area being marked by the range lights at the head of Grosse Isle. An unexpected state of affairs was discovered. Large bowlders were found scattered along in the channel and some bed rock was found above the grade of the bottom of Limekiln Crossing. The channel is navigable for vessels drawing not more than 16½ feet.

All the bowlders and bed rock in and near the channel will have to be removed to the same grade as the Limekiln Crossing work, in order to render Limekiln Crossing and the ship channel connecting waters of the Great Lakes between Chicago, Duluth, and Buffalo available for a 20-foot navigation.

The approved estimate for obtaining a channel 20 feet deep and 800 feet wide from the head of Ballards Reef to the head of Limekiln Crossing is $180,000, of which $28,742.66 is available from appropriation made under previous estimate, leaving $151,257.34 to be appropriated. all of which will be required during fiscal year ending June 30, 1896.

A map showing the obstructions in Detroit River from Ballards Reef to Limekiln Crossing and from Limekiln Crossing to section 8, ship channel, is forwarded herewith.

Total expenditure to June 30, 1893	$703,947.21
Expended during fiscal year	420.54
Total expenditure to June 30, 1894	704,367.75

The work is in the collection district of Detroit, Mich. The nearest port of entry is Detroit. The nearest United States light-houses are Mammy Judy and the range lights at the head of Grosse Isle, about 5 miles distant.

Money statement.

July 1, 1893, balance unexpended	$29,163.20
June 30, 1894, amount expended during fiscal year	420.54
July 1, 1894, balance unexpended	28,742.66
Amount (estimated) required for completion of existing project	151,257.34
Amount that can be profitably expended in fiscal year ending June 30, 1896	151,257.34

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Appropriations for improving Detroit River, Michigan.

June 23, 1874	$25,000	July 4, 1884	$200,000
June 18, 1878	100,000	August 5, 1886	37,500
March 3, 1879	50,000	August 11, 1888	130,500
June 14, 1880	50,000	July 13, 1892	30,000
March 3, 1881	50,000		
August 2, 1882	60,000	Total	733,000

COMMERCIAL STATISTICS.

Commerce of Detroit River during the season of 1893, comprising staples only, and only such staples as cleared from United States ports.

Commodities.		Amounts.	Tons.
Iron ore and finished iron			6,800,521
Coal			6,921,303
Wheat	bushels	70,516,116	2,137,155
Flour	barrels	9,528,794	952,879
Corn	bushels	57,600,309	1,612,808
Flax seed	do	4,624,154	140,125
Malt, barley, and oats	do	28,153,832	633,961
Copper ore			87,993
Stone			219,695
Salt	barrels	443,786	68,290
Provisions			325,500
Lumber	feet B. M.	929,081,000	1,393,621
Shingles	pieces	28,033,000	4,683
Laths	do	16,310,000	3,200
Cement	barrels	740,506	105,786
Unclassified freight			1,640,682
Telegraph poles	pieces	171,480	21,200
Cedar posts	do	3,401,080	22,500

Number of vessels, 33,165; tonnage, 23,091,889 (exclusive of Canadian vessels).

Total number of vessels and tonnage cleared from all the collection districts on the chain of lakes.

Vessels	51,649
Registered tonnage	34,571,208

Number of cars loaded that crossed Detroit River during 1893.

East bound	183,618
West bound	121,323
Total	304,941
Tonnage at an average of 15 tons per car	4,574,115

M M 9.

REPORT OF BOARD OF ENGINEERS UPON RAFT-TOWING ON THE GREAT LAKES AND THEIR CONNECTING WATERS.

[Printed in House Ex. Doc. No. 22, Fifty-third Congress, second session.]

UNITED STATES ENGINEER OFFICE,
Detroit, Mich., November 9, 1893.

GENERAL: The Board of Officers of the Corps of Engineers, U. S. Army, authorized by joint resolution of Congress, approved February 3, 1893, and convened by Special Orders, No. 7, headquarters Corps of Engineers, U. S. Army, February 23, 1893, "to investigate the subject of raft-towing on the Great Lakes and their connecting waters, and to report to Congress as to what restrictions, if any, should be placed upon the size and manner of constructing and towing rafts upon said Great Lakes and their connecting waters," has the honor to submit the following report:

The detailed proceedings of the Board, together with the arguments and statistics presented by the various interests concerned, are forwarded herewith as appendices* as follows:

Appendix A. Proceedings of the board.
Appendix B. Brief of the Lake Carriers' Association.
Appendix C. Brief of the Raft-Towing Association.
Appendix D. Reply to latter by the Lake Carriers' Association.
Appendix E. Letter from Capt. D. C. Kingman, Corps of Engineers, U. S. A.

The Board, after duly considering the subject as presented by both parties, viz, the Lake Carriers' Association and the Raft-Towing Association, taken in connection with the personal knowledge and experience of the individual members of the Board, concludes:

(1) That raft-towing, as now conducted on the Great Lakes and their connecting waters, is a serious impediment to navigation, and is a menace to life and property.

(2) That it causes great inconvenience and expense to the Government by the destruction of buoys, stakes, and other marks placed to define the channels.

(3) That this displacement of buoys, stakes, etc., adds materially to the risks of navigation.

(4) That raft-towing should be regulated by clear and comprehensive laws which shall include adequate penalties for their violation.

The Board, therefore, recommends the following legislative restrictions:

(1) That the towing of logs in what are known as "bag" or "sack" rafts on the open waters of the Great Lakes shall be permitted; but that every vessel having a raft in tow shall carry, between sundown and sunrise, in addition to the colored signal lights prescribed by Treasury Regulations, two white lights showing all around the horizon not less than 8 feet apart and in a horizontal line, and at least 20 feet above the deck; that for use in thick or foggy weather said vessel shall carry what is known as a screeching whistle, to be sounded under the same rules and regulations for giving fog signals as are now in force upon steamers having tows; the use of such screeching whistles upon vessels not having rafts in tow being declared illegal except for fire or police boats engaged in their duties as such; and that each failure to display said lights or to sound said whistle shall constitute a separate offense, punishable as hereinafter provided for.

(2) That it shall be the duty of every vessel towing a raft to give at least half the channel way wherever the width of channel will permit to vessels passing in the same or an opposite direction, and each failure to thus give way when practicable shall constitute an offense, punishable as hereinafter provided for.

(3) That it shall be the duty of every vessel having a raft in tow to avoid running over or against Government buoys, stakes, or other channel marks, wherever and whenever practicable; that the willful destruction or displacement of any of said buoys, stakes, or other channel marks shall constitute an offense, punishable as hereinafter provided for; and that, furthermore, in case of the unavoidable destruction or displacement of any of said buoys, stakes, or other channel marks, it

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*Not reprinted; printed in House Ex. Doc. No. 22, Fifty-third Congress, second session.

shall be the duty of the master or other person in charge of said towing vessel to report the fact to the light-house inspector of the district by telegraph, if possible, and if not possible, then by mail or otherwise, at the earliest practicable moment.

(4) In all channels and harbors marked by buoys, stakes, or other channel marks, or where passage between piers, or alongside of revetted banks is necessary, rafts shall be so constructed that the boom logs surrounding the rafts shall overlap each other, outward and aft, from front to rear, at least 3 feet, and be fastened together by chains, ropes, or other fastenings short enough to prevent the laps straightening out, and failure to so construct each raft shall be an offense, punishable as hereinafter provided for.

(5) That in and through connecting and connected waters of the Great Lakes, such as harbors and rivers with narrow entrances and channels, no bag rafts shall be permitted, under penalty as hereinafter provided for.

(6) That when any vessel and its tow of logs in bag or sack rafts are obliged by stress of weather to take refuge between entrance piers, or in any narrow channel of a river or harbor, the burden of proof as to the necessity of so taking refuge being upon the towing vessel, the raft shall be at once reconstructed so as to leave at least half the channelway clear, and the whole raft shall be moved as soon as possible out of the way of passing vessels; and that each and every period of twenty-four hours after the first twenty-four hours that said raft shall be left in shape to obstruct navigation shall constitute a separate offense, punishable as hereinafter provided for.

(7) That for entering and navigating all harbors with narrow channels, all rivers navigated by vessels other than rafting tugs, except in the rivers St. Mary, St. Clair, and Detroit, said harbors or rivers being on or connecting with any of the Great Lakes, and for entering or passing through the Portage Lake Ship Canals across Keweenaw Point, Michigan, logs shall be made into crib rafts, with the logs essentially parallel to each other in the direction of raft length, and be held together by frequent cross sticks, chains, or cables; and that rafts shall not be of greater dimensions either way than 50 feet wide by 600 feet long, and if longer than 300 feet, shall be handled by two tugs of sufficient power to properly control them. Each failure to comply with this restriction shall constitute an offense, punishable as hereinafter provided for.

(8) That raft-towing through either the Hay Lake Channel or the St. Clair Flats Canal shall be entirely prohibited under penalty as hereinafter provided for.

(9) That on the St. Marys River between Sault Ste. Marie and the head of Mud Lake, at a point 2 miles below the position of the Encampment Crib Light, rafts shall not exceed 600 feet in length and 60 feet in width; that they shall be securely fastened by cross-ties, or otherwise, to preserve, as far as possible, a uniform width; that each raft shall be handled by not less than two tugs of sufficient power to keep the raft under control and to move it to one side of the channel sufficiently to permit vessels to pass; and that each failure to comply with this restriction shall constitute an offense punishable as hereinafter provided for.

(10) That on the St. Clair and Detroit rivers, rafts shall not exceed in length 1,200 feet, nor in width 100 feet; that they shall be securely cross-tied to preserve uniform width; and that each failure to comply with this restriction shall constitute an offense punishable as hereinafter provided for.

(11) That for the willful violation of any of the foregoing restrictions the towing vessel shall be liable to a fine of not less than $100, and not more than $1,000; and the master or other person at the time in charge of the towing vessel shall be imprisoned for not less than one month and not more than six months for each offense, at the discretion of the United States court having jurisdiction; and that in addition to the penalties thus imposed the towing vessel shall be liable at civil action for damages occurring as a result of said willful violation of these regulations.

All of which is respectfully submitted.

O. M. POE,
Colonel, Corps of Engineers,
Bvt. Brig. General, U. S. A.
CHAS. E. L. B. DAVIS,
Major, Corps of Engineers.
CLINTON B. SEARS,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX N N.

IMPROVEMENT OF RIVERS AND HARBORS ON LAKE ERIE, WEST OF ERIE, PENNSYLVANIA.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monroe Harbor, Michigan.
2. Toledo Harbor, Ohio.
3. Port Clinton Harbor, Ohio.
4. Sandusky Harbor, Ohio.
5. Sandusky River, Ohio.
6. Huron Harbor, Ohio.
7. Vermillion Harbor, Ohio.
8. Black River Harbor, Ohio.
9. Cleveland Harbor, Ohio.
10. Fairport Harbor, Ohio.
11. Ashtabula Harbor, Ohio.
12. Conneaut Harbor, Ohio.
13. Removing sunken vessels or craft obstructing or endangering navigation.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, July 9, 1894.

GENERAL: I have the honor to forward herewith annual reports for works in my charge for fiscal year ending June 30, 1894. In carrying on the works of river and harbor improvement, I have been very faithfully and capably assisted by Mr. William T. Blunt and Mr. F. S. Burrowes, United States assistant engineers.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

N N 1.

IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

In 1834 the Raisin River emptied into Lake Erie at the southerly end of a low, marshy peninsula lying between the channel and the lake. The water at the mouth was very shallow, being over a bar on which the deepest soundings were only 5 feet.

A plan was proposed to improve the channel by cutting a canal across the neck of the peninsula and extending piers from its mouth to a depth of 10 feet in the lake. The canal thus planned was 4,000 feet long, 100 feet wide, and 10 feet deep, with sides protected by oak sheet piling secured above water to waling pieces bolted to heavy oak piles.

The amount expended in construction and maintenance of the channel from 1835 to 1882, inclusive, was $213,515.27.

The original construction was completed many years ago, and a light-house and keeper's dwelling were erected on the outer end of the north pier. The piers diverge so that the entrance is about 200 feet wide. In the remaining channel of the river to the wharves at Monroe, a distance of 2½ miles from the lake, the depth is 9 feet or more, and about the same depth is maintained over the bar.

All depths given refer to mean lake level, and the actual depths are greater or less according to the stage of water in the lake. In strong westerly winds the water is blown from the west end of the lake, and the surface level at the mouth of the Raisin River has occasionally dropped to a plane 7 feet below mean lake level. Easterly winds, on the other hand, raise the surface level at that point, so that in extreme cases the surface is about 5 feet above the mean level. The extreme range, mainly due to winds, in the last two years is approximately 12 feet. The figures are given as approximate only, for the reason that the gauge readings have been taken at stated hours each day, and it therefore happens that the extreme range is not taken unless its time coincides with the hour of reading the gauge.

In 1886 a project was adopted to repair the piers and canal revetment and to dredge channel if necessary. The original estimate of cost was $20,000. The work being old, however, deteriorated faster than the repairs were made under very small appropriations, so that in 1891, after $12,000 had been expended, covering five years, it became necessary to increase the estimate for completion to $26,000, which was equivalent to making the original estimate $38,000.

The appropriations made under the project for repairs, etc., approved in 1886, are as follows:

August 5, 1886	$2,000.00
August 11, 1888	5,000.00
September 19, 1890	5,000.00
July 13, 1892	10,000.00
Total	22,000.00
Total of appropriations for construction, maintenance, and repairs, 1835 to 1892, inclusive	235,515.27

Amount expended on project of 1886 to June 30, 1893, including liabilities	14,569.83
Amount expended in last fiscal year	7,345.17
Total	21,915.00

At date of last annual report the repairs of superstructure of north pier had been commenced, the work being done by hired labor and purchases in open market, as the most economical and advantageous method.

The repairs were commenced June 5, 1893, and completed September 23, 1893. The superstructure of north pier was rebuilt throughout its entire length, except the pier head upon which the light-house and dwelling stand. This included a total length of 1,122 linear feet of superstructure, 852 feet of which is 24 feet wide, 115 feet is 8 feet wide, and 155 feet is 10 feet wide. The superstructure is 6 courses, or 6 feet high from water level.

In this repair the following accounts appear for material and labor:

204,566 feet, B. M., pine timber	$5,265.10
6,240 pounds driftbolts	115.42
105¼ cords stone	627.72
2,400 pounds spikes	59.00
24 pounds iron	.54
Tools	18.29
Hire of boat and scow	50.25
Superintendence and labor	1,805.48
Steamer and crew	198.67
Total paid out for repairs on north pier	8,140.47

The repairs included tearing away all the old superstructure, wood and iron work; removing and replacing several hundred cords of stone; straightening and driving several thousand pounds of driftbolts taken from the old work, and doing much other work which would not be required in an entirely new construction.

By multiplying the amounts of new material purchased, by the contract prices for new material at Huron, the nearest similar work on Lake Erie, and adding thereto the cost of superintendence, which was included in the foregoing statement, it will be seen that the new materials only at the contract prices would cost as much as the entire work, old and new, by hired labor and open purchases. The recommendation to do the work by the method described has therefore been fully justified.

The south pier and the old revetments in canal are in need of extensive repairs for the preservation of the channel. It is believed that the amount estimated for the completion of repairs will be sufficient, provided the appropriations be not too long delayed.

The commerce of Monroe is very small, so that no further deepening of the channel is likely to be required. The old pier and part of the revetment of canal should, however, be repaired, and it is therefore recommended that the balance of $16,000, previously estimated, should be appropriated in a single sum.

No commercial statistics were received.

The harbor of Monroe is in the collection district of Detroit, Mich. There is a light-house on the outer end of the west pier.

Money statement.

July 1, 1893, balance unexpended	$9,692.72
June 30, 1894, amount expended during fiscal year	9,592.72
July 1, 1894, balance unexpended	100.00
July 1, 1894, outstanding liabilities	15.00
July 1, 1894, balance available	85.00
Amount (estimated) required for completion of existing project	16,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	16,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

N N 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

The original project for improving this harbor was adopted in 1866, pursuant to the requirement of river and harbor act approved June 23, 1866, which appropriated $20,000 for the improvement. The project provided for improving the old channel through Maumee Bay by dredging to a depth of 12 feet and width of 200 feet. The plan was amended from time to time as necessities increased, until the old channel had been dredged to a depth of 16 feet. In 1892 it had filled somewhat, so that the mid-channel depth was about 15.5 feet.

The total amount appropriated and expended on the old channel is $724,332.61.

In 1887 a project was approved by the Secretary of War for a straight channel through Maumee Bay, in compliance with previous acts of Congress. The channel was so located as to utilize the old channel as far as possible, and was to be 200 feet wide at the bottom and 17 feet deep.

Upon the basis of protecting the channel by revetments or piers through at least a part of its length, the cost of the project was estimated to be $1,875,000.

Expenditures incurred on straight channel to June 30, 1893	$488,892.95
Incurred in last fiscal year	94,312.53

Previous to June 30, 1893, the channel had not only been dredged throughout practically as planned but much of it had filled, more or less, and had been re-dredged.

In 1893 the officer in charge of the work urged the necessity of a wider channel than 200 feet, and this has been approved for the lake subdivision, which includes the part between the range lights and the lake.

At the beginning of the fiscal year the channel had been considerably filled by drift and silt. The parts between the range lights at the turn-out and the mouth of the river have filled an amount which makes the annual average thus far closely approximate 6 inches. The lake subdivision has been more recently completed and the observations for ascertaining the amount of fill have been less extensive, but doubtless the average will be less than for the part nearer the river.

For a further discussion of this part of the subject I refer to the report of Mr. William T. Blunt, assistant engineer, appended hereto.

The drawing showing channel sections mentioned by Mr. Blunt is forwarded to accompany this report, and also a map of Maumee Bay showing the location of straight channel, and a part of Maumee River showing the part over which the improvement is to be extended in accordance with plans already approved.

At the beginning of the fiscal year work was in progress under a contract with Messrs. G. H. Breymann & Bros., of Toledo, Ohio, for dredging in the straight channel. Dredging has been continued during the year except when suspended for the winter, from November 24, 1893, to April 1, 1894, inclusive.

The amount dredged during the year is as follows:

	Cubic yards.
From inner section	36,638
From turn-out section	974
From outer section	242,744
Total	280,356

The fill is mainly near the banks of the cut, as shown in the drawing with Mr. Blunt's report. In clearing the channel, therefore, the cuts have been made near the banks and deeper than the grade which is intended to be maintained. In the outer and turn-out sections the cuts have a depth of about 19 feet, and in the inner section cuts have been about 20 feet deep. Most of the channel now has a middle depth of 17 feet, but most of the inner division has that depth in the middle only, and on the outer edges it is very much less.

The question of maintaining the channel was discussed in the Annual Reports for 1892 and 1893, with the conclusion that it could be best done by dredging and that the dredging could be most satisfactorily and economically done by a dredging plant owned by the United States.

Under authority of the Chief of Engineers the plant has, therefore, been purchased, consisting of the dredge, 4 scows, and 1 tug. Three of the scows are dump scows, and one has a flush deck. It has been found that owing to the long distance to which part of the material must be towed that three dump scows are not enough. Authority has, therefore, been obtained to purchase another scow, and that will soon be added to the fleet.

The river and harbor act of July 13, 1892, provided that a part of the appropriation might be used, in the discretion of the Secretary of War, in removing shoal in old channel and in extending the improvement up the Maumee River.

The last Annual Report explained the reason why it was considered inadvisable to attempt any more dredging in the old channel. A survey of the river from its mouth to the bridge of the Pennsylvania Railroad Company, about 4 miles above, disclosed a shoal place in the part known as the "Crossing," between the bridge mentioned and the bridge of the Wheeling and Lake Erie Railroad Company, some distance below.

A communication was submitted to the Chief of Engineers March 19, 1894, to dredge a channel through the shoal, cutting to a depth of 19 feet between the curves of 18 feet depth, and to make the channel so dredged 400 feet wide. This recommendation was approved. The estimated cost was as follows: Dredging 150,000 cubic yards, at 12 cents, $18,000.

This amount is to be expended as far as may be necessary in operating the new dredge plant recently purchased. The dredge commenced work upon this channel on May 8, 1894; on June 30 it had worked thirty days and had removed 28,102 cubic yards of material. Considerable delay was caused by the necessity for towing the dump scows a long distance, and it is to prevent such delays that another scow is to be purchased.

The officer in charge of the improvement hoped to have procured a dredging plant which would have far less delays from breakage of machinery than has been usual among other dredges on the lake. Experience here has been that in the first year many delays occur from accidents of various kinds, owing to imperfections in the machinery or its adjustments.

The cost of operation of the plant, however, including all delays and repairs, has been a trifle less than the estimate of 12 cents per yard, which is as low as the lowest contract price obtained in this district for many years.

The original cost of the straight channel was made upon no definitely matured plans. It was estimated that the amount of dredging would be 1,580,000 cubic yards, and that the price per yard would be 14 cents. The details of the balance of the estimate, however, do not appear in the records of this office.

In 1893 the officer in charge of the improvement submitted recommendations regarding the method of completing the improvement, with a view to revising the estimate of cost of completion and of continuing the work upon a definite plan. Among the recommendations were the following:

(1) That a small part of the lake subdivision of the channel be protected by dikes, the work to be first tested regarding its effect by constructing an experimental section of 4,000 feet.

(2) That the channel width be increased from 200 feet to 300 feet throughout.

(3) That certain repairs be made to old work. (See Report of Chief of Engineers, pp. 3053–3056.)

The subject was referred to Colonel Abbot, who did not fully concur in the recommendations, but said:

> The funds originally estimated appear to be ample to provide for a continuation of the work, as heretofore, without hampering the Department by details for which existing data are inadequate, and in my judgment the approval of such a project would be premature.
>
> In view of the large amount of commerce which will use the channel, of the short distance between range lights, and of the reserve of funds covered by the estimates, I concur with Col. Smith in thinking that an increase in width to 300 feet in this lake subdivision is advisable, and recommend that it be authorized. Within Maumee Bay I am not satisfied that the increase is as yet demanded.

The widening to 300 feet in the lake subdivision, having been approved by the Chief of Engineers, has become part of the project of improvement. The estimate, however, has been left, as heretofore, simply an amount upon which to draw without being hampered by details for which the data are considered inadequate.

Many of the reasons why the wider channel is needed were discussed in the last Annual Report. The filling in the channel being mainly from the edges tends constantly to make it narrower.

The inner division is about 4 miles long, and the distance between the beacons of range is only about 1,000 feet. To follow such a long, narrow channel on such a short range is very difficult, because a very slight variation from the range throws the vessel upon the bank. The difficulty is greatly increased when other vessels are passing to and fro in the same channel.

In the spring of 1893 the Detroit and Cleveland Steam Navigation Company made arrangements for a line of steamers to run to Toledo. Under date of April 21, 1893, the general manager of the company wrote as follows:

> Our captains (after seeing the straight channel) and other captains say that it would be impossible to steer a wide boat like ours (70 feet) out of the 200-foot channel in the night without going aground.

In September, 1893, the general freight agent of the Detroit and Cleveland Steam Navigation Company wrote to this office as follows:

> CLEVELAND, OHIO, *September 27, 1893.*
>
> DEAR SIR: Commencing with the opening of navigation this season we extended our Lake Huron division to Toledo; but after advertising our steamers we found that, owing to the narrow channel and lack of range lights, it was impossible for us to run in or out of the Maumee River during the night.
>
> The channel is so narrow that two steamers the size of our side-wheel boats (76-foot beam) can not pass safely at night; and it is with difficulty that they can pass each other even in the daytime; for as soon as their speed is checked their high cabins, which catch the wind, will cause them to drift to one side or the other, as the wind may direct, and put them aground.
>
> We are very desirous of running regularly to Toledo, and think it is a place from which we could get considerable traffic, both passenger and freight, if the channel was widened to, say, 300 feet from the outer light-house to the mouth of the river, and range lights put in range with the straight channel.
>
> I would suggest that the range lights be red and of sufficient power to show as

far as the outer light-house. The reason for suggesting red lights is that it would be hard to distinguish a bright light from the Toledo lights. Any mistake in distinguishing these lights might result in serious loss. Therefore we think that red lights would be more suitable for this particular place.

In view of the foregoing facts we would respectfully ask that you try and supply the much-needed lights and the widening of the channel.

Awaiting your reply, I am,

Yours, very truly,

D. C. McIntyre,
General Freight Agent.

Col. Jared A. Smith,
U. S. Engineer.

It will be seen that at least one line of large steamers has been compelled to stay away from Toledo because the channel is too narrow.

The dredging now under contract will be continued until the fill in channel has been removed, and should any funds then remain the widening of lake subdivision will be commenced.

The dredge belonging on the improvement will be continued on the shoal in the river until the channel through it is completed, when it will be put to work in the straight channel.

Another shoal in the river is reported to cause great inconvenience to navigation, and it is proposed to extend the survey up the river during the present season and to include the shoal. A further plan will then be submitted, in accordance with the requirements, to extend the improvement up the Maumee River.

The following appropriations have been made since the adoption of the project for a straight channel:

July 5, 1884	$25,000.00
Deduct amount appropriated for old channel (see note)	9,632.61
	15,367.39
August 5, 1886	112,500.00
August 11, 1888	150,000.00
September 19, 1890	200,000.00
July 13, 1892	200,000.00
Total	677,867.39

Note.—By act of August 5, 1886, the balance then available of the $25,000 appropriated July 5, 1884, for straight channel was made available for clearing the old channel.

Toledo is in the collection district of Miami. There is a fixed white light of the fourth order on Turtle Island and three sets of range lights for parts of the channel.

Money statement.

July 1, 1893, balance unexpended	$194,972.55	
Deposited to credit of appropriation	*50.00	
		$195,022.55
June 30, 1894, amount expended during fiscal year		98,537.45
July 1, 1894, balance unexpended		96,485.10
July 1, 1894, outstanding liabilities	2,380.97	
July 1, 1894, amount covered by uncompleted contracts	51,740.44	
		54,121.41
July 1, 1894, balance available		42,363.69
Amount (estimated) required for completion of existing project		1,200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

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* During fiscal year ending June 30, 1894.

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER.

CLEVELAND, OHIO, *June 30, 1894.*

SIR: I respectfully transmit herewith a tracing showing typical cross sections on the inner division of straight channel through Maumee Bay, Toledo, Ohio.

These few are selected simply because time would not allow of the sounding of the whole line, and they are located in such places as to warrant the belief that they are truly typical, as they have been in the more complete surveys of the past. On them are shown:

The original bottom before straight channel was begun in 1877.

The bottom taken immediately after dredging was completed to 17 feet in 1889 and 1890.

The bottom at the present time, from four to five years after completion.

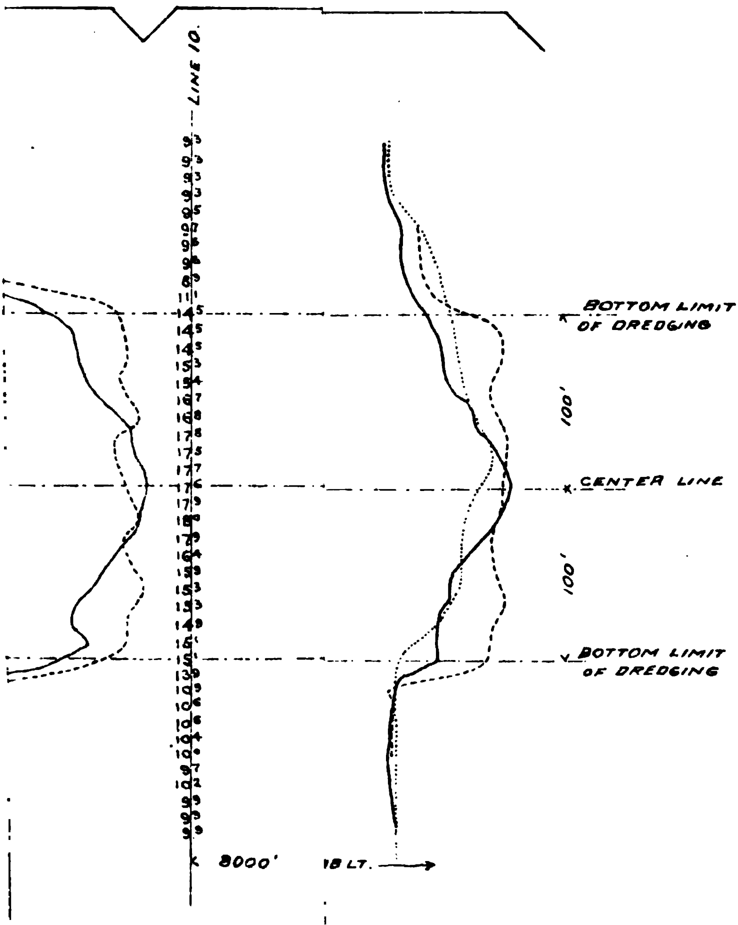
The first and second were taken from complete surveys of the entire line, and all were under my immediate supervision, as was the dredging between the first and second. No dredging, except in one small locality, not covered by these sections, has been done between 1890 and the present time. The original soundings were taken as soon as the line was adopted in 1887 and before contracts were let. The next complete set of soundings was taken in each section of 800 feet length as soon as it was completed and the dredge removed from it. Thus the soundings in each 800 feet show the immediate actual results of the dredging in that section. Other complete sets were taken in the interval between then and now, but the more recent soundings (June, 1894) are used as giving the longest period for comparison.

It must be understood that these sections are all between the crib light and the mouth of the river. Beyond the crib the conditions are somewhat different, and will be elaborated later. At present it is sufficient to say that the dredging of the outer division was not completed till June, 1892, and a new contract to remove the fill was begun in 1893 and is now in force. This report will consider the subject as of two divisions: The inner division from mouth of river to crib light, 23,644 feet; and the outer division from the crib light to the lake, 16,000 feet.

Inner division.—In this division we find two separate conditions originally. From the mouth of the river to the old Black-can Elbow, to use its popular name, a distance of 12,000 feet, the channel was entirely new, having been excavated through a clay bottom with some sediment on top and having had an original depth of from 5 to 9 feet, averaging 7½ feet. From the Black-can Elbow out to the crib, a distance of 11,644 feet, the new channel followed the old one, which had been dredged at various times and with varying results, usually, however, holding 16 to 17 feet middle depth, decreasing to 13 feet along its sides and with 9 to 11 feet on its banks; the average depth within the adopted lines, 200 feet apart, was 14 feet. The material was to a great extent sedimentary deposit in the old cut, though clay was found whenever a deeper or wider cut was taken than those formerly made.

The last dredging of any amount done on the inner division was under contract with James Rooney, in 1889 and 1890. A depth of 17 feet being required, it was soon found that cuts to that depth over the entire width left but about 16¼ feet average depth. As soon as this was determined the cuts were changed to 18 feet, and thereafter the results were 17¼. Careful studies then and since have proved conclusively that to obtain a certain depth over a series of cuts, in the ordinary methods of dredging, it is necessary to dig three-fourths foot deeper. The results may be described as follows: On first cut depth is left nearly as dug; on second cut the same result follows, but the first cut will show a fill of three-fourths foot or thereabout, due to various causes, such as overthrow from dipper, leakage from scows, spatterings from pockets, cutting of banks by tug wheels, etc. This action follows on succeeding cuts, so that when full width is completed we find all except the last cut to show about three-fourths foot less water than was dug. This result has followed invariably, not only over a large area but on each separate cross line. It is possible, of course, by taking a half cut so as always to throw dipper toward the bank, and by always keeping scows on bank side and with greatest of care in digging, to realize nearly the actual depth cut; but experience here has shown that it is not economy of time or patience; that equally good results are obtained in shorter time, with less rigidity of inspection and at greatly reduced cost to contractor. The channel is benefited by having three-fourths foot of soft, broken-up material below the depth required (especially in a clay cut), and by being available earlier and at less cost for inspection. The contractor is greatly benefited by being allowed a full width of cut and the deeper face.

The resulting depth over the entire inner division varied from 16 to 18 feet, averaging 17¼, and all cross sections showed a remarkable agreement in this, seldom varying in their averages more than 0.2 foot. Now, from four to four and a half years afterward, the depth is from 13 to 18 feet, with an average of about 15.3, showing a general fill of 2 feet in four years, or 0.5 foot per year. Assuming the sectional area of fill to be 400 square feet, which is probably a close approximation,



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we have a total fill in four years, of about 350,000 yards, or in one year 87,500 yards on 4 miles of channel. Most of this fill, being of a very soft nature, has been forced to the sides of the channel by action of vessel wheels, so that along the middle the depth of 17 feet and more still obtains for widths of from 40 to 80 feet. It is a mixture of sand and mud, and in the nature of a deposit pure and simple. It is not caused by washing in of banks, as in nearly every case the bank soundings remain as before dredging. Sloughing off is noticeable in a few instances, but only to a slight extent, and by no means enough to account for the sectional area of fill which exists (300 to 500 feet). The fill is nearly the same over the whole line, and not concentrated at any one locality. The conclusion is inevitable that it is simply the deposit of semisuspended material in the deep cuts, carrying out the natural tendency in a bay like this to even off its bottom.

Undoubtedly much material comes down the river in flood seasons, but its course is out the old channel to the northward from the mouth of the river, and thence in general distribution over the bay. No permanent outward current exists at other times, the river for some miles above its mouth being simply an arm of the bay and lake, influenced in its currents only by the winds. Thus the current along the city front 5 miles from the mouth is as often up as down stream. The waters of river and bay are never clear, but have in suspension a large amount of sedimentary matter, undoubtedly thicker and heavier toward the bottom; consequently any deep cut through them will accumulate this material indefinitely, while the banks of the cut, being nearer the surface, will retain only their normal amount. The result is, dredging indefinitely. In this locality, the task is made easier by passing boats, which unconsciously assist us by piling the material along the sides, ready for removal, so that we may practically clear the channel by side cuts rather than by "planing off" the whole width.

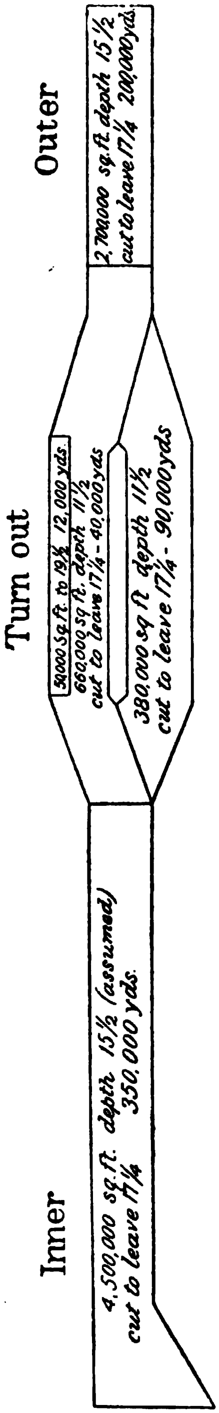
Outer division.—Here we find the conditions somewhat different from those inside the cribs. Clay bottom is found at a depth of 11.4 feet at the crib, and slopes gently outward and downward until it disappears at 18 feet depth 9,000 feet from the crib. On top of this is a deposit of sand and mud, leaving a depth of 11 feet nearly level from crib to 7,000 feet out. From this point a bar of perfectly clear sand rises gradually, leaving a minimum depth of 6.3 feet on its crest at 9,000 feet from the crib, thence gradually deepening to the lake. It is the prolongation of the Turtle Island Bar reaching toward Cedar Point.

On this division we still find sedimentary deposit inside the bar, though much heavier than those on inner section. On the bar and beyond the bottom is of clean, sharp sand packed so solidly that a sounding rod dropped on it rebounds upward with a ringing sound.

The first dredging done here was in 1889, when the crest of the bar was cut through to a depth of 13 feet. Immediately afterwards (September, 1889) soundings showed an average depth of 12.3. In June, 1890, no perceptible change was discovered, even to the marks of dipper cuts on the bank. This was rather against all previous calculations, as all concerned had believed that at this point the channel would surely fill. The final dredging to complete this outer division was done in 1891 and 1892, under the supervision of Lieut. W. V. Judson, Corps of Engineers, U. S. Army. In a report on the subject (Annual Report Chief of Engineers, U. S. A., 1892, p. 2491, Appendix M M) Mr. Judson states that the average depth obtained was 16.8 feet. In April, 1893, a survey made under my supervision gave an average depth of 15.5 feet. This would indicate an average fill of 1.3 feet in about eighteen months, but the time being so short and boats having used that part of the channel so little, it seemed hardly advisable to adopt this comparison as conclusive of the amount of fill. Throughout the division the fill is very evenly distributed over length and breadth. Now that this portion is buoyed and will soon be lighted, vessels will begin to use it as frequently as they have the inner division. Whether that will have the same effect in throwing material to the sides as it has on the inner portion remains to be seen; it probably will not to a large extent through the bar and outward. No special locality seems to show more fill than another. The banks remain with same depth as in 1887 except on the immediate crest of the bar, where they have been lowered from 1 to 3 feet. Even here an explanation quickly presents itself in the fact that barges loading sand through pumps have very probably caused the lowering. The foregoing seems to indicate that on the outer division the whole width will have to be dredged occasionally.

Present contracts.—The present contract with George H. Breyman & Bros. is progressing rather slowly, with only one dredge. It covers the entire length of channel and also the river approach. Nearly all the material to be removed is in the nature of a fill, there being only two very small portions of first cuts. From the beginning of contract the work has been under the inspection of Mr. J. T. Holling. Work was begun April 19, 1893, on the river approach, but little was done there, as when weather became settled the dredge was placed at work on the turn-out around cribs. This was opened up to full width of 200 feet and most of the fill cleared out. Work was then continued along outer division until late in November, when severe weather compelled cessation. It was resumed April 26, 1894, and outer division completed early in June. Dredging was carried to 19 feet, leaving about 18¼ feet, which still holds throughout with little variation for full width. Dredge is now working on inner division, inward from the crib.

On May 10, 1893, I submitted to you the following letter and table as basis for work under this contract:


Outer
2,700,000 sq.ft. depth 15½
cut to leave 17¼ 200,000 yds.
Turn out
30000 Sq.ft. to 19½ 12,000 yds.
660,000 sq ft. depth 11½
cut to leave 17¼ - 40,000 yds
380,000 sq ft depth 11½
cut to leave 17¼ - 90,000 yds
Inner
4,500,000 sq.ft. depth 15½ (assumed)
cut to leave 17¼ 350,000 yds.

TOLEDO, OHIO, *May 10, 1893.*

SIR: Up to this time, by taking advantage of all possible working weather, we have only been able to sound the turn-out section, the outer section, and the vicinity of the junction of straight channel and mouth of river. The dredge is now completing the cut to 19½ feet to obtain full width of north turn out, and it becomes necessary to determine the method of cutting on outer section. A study of the soundings obtained shows:

In outer section, an average depth over the whole length and width of 15.6 feet. The fill has taken place very evenly over whole width, with a slight tendency to fill most on southerly side of channel. It is also remarkably even over the whole length.

In turn-out section, very irregular, with depths from 14.9 to 18.7 feet. Shoal places, apparently left by dredges, as they appear in ridges.

In inner section, the 4,000 feet sounded near inner end show a channel depth of 17 feet and over with considerable fill on either side, mostly on southerly side. This fill does not come from washing in of banks, depths there remaining for the most part as they were before any cuts were made (in 1887).

In river division, very irregular, 14.4 to 18.7 feet. Shoal places in ridges, as if left by dredges.

Conclusions based on these data would seem to be as follows:

In outer and turn-out sections it will be impracticable to dig two or even three deep cuts as it would leave the remainder too shoal to warrant the supposition that it would "even off."

In inner section, if the balance of channel length is as favorable as that already sounded, it may be advisable to confine dredging to the sides of channel.

In river division the shoal places may be selected for removal.

As a part of this letter I hand you rough sketch with table showing areas, depths, and quantities in the various localities. Table shows, "Estimates in specifications," "Present estimates," and "Proposed distribution," which, if you see no objection, I respectfully recommend for adoption.

When the two turn-out channels were first proposed by me, in 1890, it was intended that the "island" around cribs should be much wider than the pile work is now constructed. With its present dimensions, the bends in the channel are very light, and there is no immediate need of the southerly channel. The cost of dredging it (about $12,600) can very much better be spent on other parts of the work, and I therefore recommend that it be abandoned as far as this contract goes. If it is not abandoned, the entire channel can probably be "planed off" to a depth of 17¼ feet (see "Present estimate") or its equivalent in quantity taken in fewer cuts. If it is abandoned, it will enable us to obtain a depth over full width and length of outer section of 18¼ feet and of 17¼ over remainder of channel. The outer section, being much more exposed, should have some better water.

I think this dredge can, with four cuts, reach nearly the full width of 200 feet. I should then allow her to dig to 19½ on dipper arm and expect to find bottom at about 19 or 18¼, with ridges between having not less than 17½ or 18, and an average depth of 18¼ as above noted. This, however, should be a matter for study and determination after a trial has been made. The hull is 35 feet wide, and we have noted that with

19½ feet on dipper arm she has made 17 feet depth at about 15 feet from her side. Thus she could easily carry out the above suggestion.

Very respectfully,
Wm. T. Blunt,
Assistant Engineer.

Lieut. Col. Jared A. Smith,
Corps of Engineers, U. S. A.

This met with your approval, and the south turn-out was abandoned by consent of the contractor.

In accordance with your recent approval, the dredge is now cutting to 21 feet on extreme outside cuts and to 19 feet on next inside, leaving about 40 feet in width along the middle untouched, with present depth of about 17 feet. Under this method the greatest good will accrue to the channel, though the estimate of May 10, 1893, was not based on so deep a cut, but on 18 feet throughout. If not possible to cover the entire length of inner division, the portion left will still be in very fair condition, considering its position near the river mouth.

Very respectfully,
Wm. T. Blunt,
Assistant Engineer.

Lieut. Col. Jared A. Smith,
Corps of Engineers, U. S. A.

Toledo, Ohio, straight channel.

	Price.	Estimate in specifications.		Present estimate (cut to 18, leave 17½).		Proposed distribution.		
		Cubic yards.	Cost.	Cubic yards.	Cost.	Depth.	Cubic yards.	Cost.
Outer	$0.16	110,000	$17,600	200,000	$32,000	Cut to 19, leaving 18½.	300,000	$48,000
Turn-out, north	.14	175,000	24,500	52,000	7,280	Cut to 18, leaving 17½.	52,000	7,280
Turn-out, south	.14			90,000	12,600	Abandoned for the present.		
Inner	.12	Balance.	57,900	350,000	42,000	Cut to 18, leaving 17½.	350,000	42,000
Total			100,000		93,880			97,280

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Toledo, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Iron ore	159,005	Grain	491,036
Coal	145,371	Coal	290,152
Lumber and logs	58,943	Flour	29,375
Plaster and cement	17,109	Lumber	23,932
Salt	6,960		
Sugar	4,883	Total	834,495
Total	392,271		

Total freight tonnage for 1893	1,226,766
Total freight tonnage for 1892	1,763,003
Decrease	536,237

Shipping.	Number.	Tonnage.
Vessels entering	1,931	862,999
Vessels departing	1,923	854,475
Vessels built	6	1,073.03

Total registered tonnage for 1893 (vessels entering and departing)	1,717,474
Total registered tonnage for 1892 (vessels entering and departing)	1,979,426
Decrease	261,952

Draft of largest vessels using harbor, 21 feet.

These can not load to full depth because the shallowest places in channel do not exceed 16 feet in depth at mean lake level.

The steamers of the Detroit and Cleveland Line make irregular trips to Toledo twice or more weekly.

N N 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

Previous to 1870 the channel at the entrance to this harbor, which is in the mouth of Portage River, was narrow and crooked, with a depth not exceeding 5 feet. In that year an examination and report was made in compliance with requirement of the river and harbor act approved July 11, 1870.

The sum of $10,000 was expended in 1872 and 1873 in dredging a channel 20 feet wide and 8 feet deep over the bar, and constructing a sand fence to prevent filling the channel by drifting sand.

In 1875 it became apparent that the channel could not be maintained without piers, and a plan was adopted for constructing piers, at an estimated cost of $122,000. A cheaper construction was subsequently adopted and the estimate was modified to $90,000.

Work of dredging and extension of piers was carried on under various appropriations until 1883. The last work upon the east pier was an extension of 150 feet in 1882, and the last work upon west pier was completed August 30, 1883, it being an extension of 150 feet. The subsequent appropriations have been applied to repairs, dredging, and purchase of land.

The following is a statement of the amount and date of all the appropriations for this improvement:

July 10, 1872	$8,000
July 10, 1872 (allotment)	2,000
March 3, 1875	5,000
August 14, 1876	5,000
June 18, 1878	10,000
March 3, 1879	10,000
June 14, 1880	5,000
March 3, 1881	5,000
August 2, 1882	$6,000
August 5, 1886	2,000
August 11, 1888	5,000
September 19, 1890	3,000
July 13, 1892	10,000
Total	76,000

The amount expended to June 30, 1893, was $66,175.54.

The channel had been dredged so that for a very narrow place it was about 10 feet deep, but was indirect, and the wharf fronts could not be reached with a draft of vessel exceeding 8 feet.

In 1882 the east pier had been extended to a point 2,180 feet from shore, leaving 420 feet of the original plan to complete.

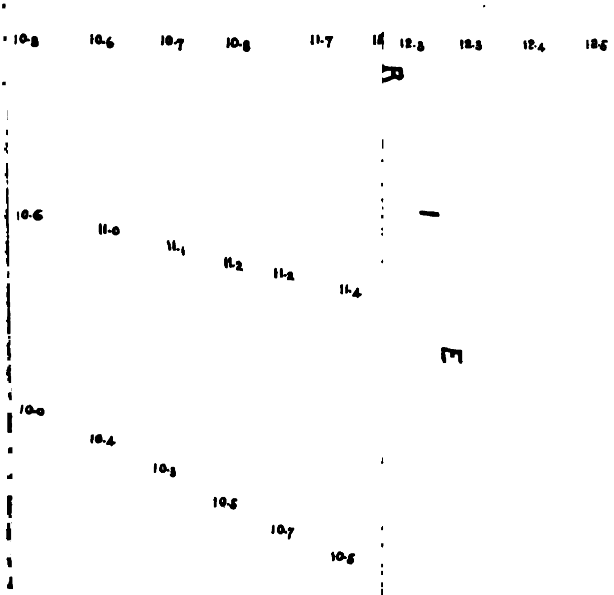
In 1883 the west pier had been extended a total of 1,948 feet, leaving 480 feet of the original plan for completion.

At the beginning of the fiscal year a contract was outstanding with Messrs. Sadler & Allen, of Detroit, Mich., for dredging in the harbor and on the bar outside and for removing a rocky shoal outside which lay in the way of vessels entering and leaving the harbor. The contract included work at several other places, so that the commencement of dredging was deferred until October 26, 1893. Work was continued, except when suspended for the winter, November 19, 1893, to April 2, 1894, inclusive, until June 26, 1894, when it was completed. The amount of material dredged under the contract was 35,491 cubic yards, measured in scows.

The specifications, which form part of the contract for dredging, contain the following paragraph:

> Should there be met any bowlders, roots, logs, wrecks, or other material which would not ordinarily be removed by dredging or measured in dump scows, the material so met with is to be removed by the contractor, and the time occupied will be paid for at a rate per hour to be determined by the average earnings per hour during three days immediately preceding.

Under this provision a large number of dangerous bowlders have been removed from the channel outside by digging deep holes along-



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side and rolling the stone into the hole. The time so worked by the dredge was 59 hours and 55 minutes.

The original time for completion of the contract, including Sandusky River, Huron and Black River harbors, was November 30, 1893. The time for completion of contract has been twice extended, the last date being August 31, 1894. The cost of inspection for the time employed in 1894 has therefore been deducted from payments to the contractor.

As a result of the dredging there is now a channel whose least width between the piers is 100 feet and along the wharf front it is 200 feet wide. The least depth in the channel exceeds 10 feet. The rocky shoal has been entirely removed to a depth of 12 feet. The material dredged was mainly a hard yellowish earth, resembling clay, with stones, gravel, and some overlying sand.

The piers, especially near the shore and on the east side, are almost rotted away above water. The east pier is simply a single row of sheet piling of 4-inch oak plank, supported by waling pieces secured to ordinary round piles. In a few places the pier is reinforced by small pile piers built for pier heads and to support a pier-head light. The west pier is built in the same manner except 720 feet of the outer end, which is a pile pier with a timber superstructure 14 feet wide and 5 feet high.

The commerce of Port Clinton is very small, and the present harbor is ample for all necessities. A map of Port Clinton Harbor is forwarded to accompany this report.

The river and harbor act of July 13, 1892, appropriated $10,000 for improving the harbor at Port Clinton, Ohio, with a proviso that "$1,200 are to be paid to Mr. Charles Roose, of Oak Harbor, Ohio, in full satisfaction for the necessary portion of the sand beach adjoining the inner end of the west revetment at Port Clinton Harbor."

Under this proviso of the law a survey of the land was made in October, 1892, and a deed was prepared and forwarded for action December 2, 1892, as indicated in last Annual Report.

The U. S. attorney for this district succeeded in getting through with the examination of title in time to permit the execution of the deed under date of May 12, 1894. Payment was made May 21, 1894, and the deed was recorded June 6 in the office of register of deeds for Ottawa County, at Port Clinton, Ohio.

The amount required to complete the project is submitted on the basis of the previous Annual Reports, deducting the appropriations made. Instead of completing the project, however, for which there appears no real necessity, it is recommended that the entire amount be appropriated and expended for making repairs which are very urgent.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest work of defense is Fort Wayne, Mich., 30 miles distant, and the nearest light-house is at Green Island, 10 miles distant.

No commercial statistics were received.

Money statement.

July 1, 1893, balance unexpended	$9,824.46
June 30, 1894, amount expended during fiscal year	7,428.30
July 1, 1894, balance unexpended	2,396.16
July 1, 1894, outstanding liabilities	1,711.69
July 1, 1894, balance available	684.47
Amount (estimated) required for completion of existing project	27,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	27,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

N N 4.

IMPROVEMENT OF SANDUSKY HARBOR, OHIO.

The harbor of Sandusky, Ohio, is in the lower part of Sandusky Bay. The entire bay forms a natural harbor, separated from Lake Erie on the north and northwest by a long narrow peninsula, and on the northeast by another peninsula, known as Cedar Point. The waters of the bay, which are shallow, being in general but 8 to 12 feet deep, are further protected from the effect of storms on the lake by a bar which extends across the entrance to the bay, except a small distance where the channel passes Cedar Point. The depth of water over the bar is in general from 4 to 6 feet.

Various appropriations for removing shoals in the channel were made from 1826 to 1879, resulting in a channel which generally had a least depth of 13 feet.

The change in draft of vessels and the increasing demands of commerce brought the necessity for a better channel, and in 1880 a plan was adopted to make a channel 200 feet wide and 15 feet deep across the outer bar to Cedar Point, a distance of about 1 mile, thence by a considerable detour following the old channel of deepest water a distance of 3¼ miles to the channel parallel to the city front which has the same depth and a width of 100 feet.

In 1888 a deeper channel became necessary, and it was considered advisable by the officer then in charge of the improvement to shorten the distance by making a channel direct from Cedar Point to the east end of the channel on city front. The channel was planned to be 200 feet wide and 17 feet deep, but the estimate did not include deepening the channel over the bar nor along the city front. The estimated cost of the new straight channel was $96,712.

The following appropriations and allotments for improvements have been made for this harbor.

From 1826 to 1879	$222,980
From 1880 to 1886, expended on channel of 15 feet depth	57,500
August 11, 1888	40,000
September 19, 1890	45,000
July 13, 1892	41,712
Total appropriated since adoption of project for straight channel 17 feet deep	126,712

Of the appropriation of August 11, 1888, $5,000 were, by the act of appropriation, made applicable to the old channel; $8,727.17 of the appropriation of September 19, 1890, were similarly expended.

The last appropriation named was for completion of the improvement, and was therefore only applicable to the part for which the estimate had been submitted. except that a clause permitted a portion of the amount appropriated to be expended on the outer bar. The law was, however, understood to require that the straight channel should first be completed. Any balance which would remain after completing the straight channel would be too small to produce an appreciable benefit, if any, and the expenditure of the small balance upon the bar was therefore not recommended.

Amount expended since adoption of present project to June 30, 1893	$69,708.53
Amount incurred in last fiscal year	29,343.18

At the beginning of the fiscal year the straight channel was considered as about two-thirds dredged. The amount remaining to complete was estimated to be 250,000 cubic yards.

Dredging was commenced under the contract with Messrs. Carkin, Stickney & Cram, of East Saginaw, Mich., July 10, 1893, and has been continued without interruption, save when suspended for the winter—November 30, 1893, to April 30, 1894, inclusive. At the end of the fiscal year the amount dredged was 200,093 cubic yards. The time originally required for completion of contract was June 30, 1894, but upon application of the contractors the time has been extended to August 31, 1894. The straight channel is, therefore, so nearly completed that it will be entirely finished at about the middle of the season.

A plan to light the new channel by two beacons located on the bar opposite Cedar Point has been approved by the Light-House Board, and the matter has been submitted to Congress with recommendation for an appropriation.

The straight channel, although it forms a great advance toward a valuable improvement, is by itself of very little value. The depth of 17 feet which it affords can not be utilized because it forms only the middle section of the channel, and affords no communication either to the city front or to the lake. One end of the straight channel reaches a point very near the wharves of the Baltimore and Ohio Railroad, but otherwise than that, it is merely a deep place in the middle of a long channel, each end of which is shallow. The outside section of the channel extends over the bar from Cedar Point to the lake, and it is not only narrow and indirect, but has much less depth than the straight channel. The channel along the dock front does not exceed 100 feet in width, and it has become so much filled that the depths range from 13 to 14 feet only.

Sandusky Harbor is in the collection district of Sandusky, Ohio. There is a light-house on Cedar Point with a fixed white light of the fifth order, and three range lights within the bay. Fort Wayne, Mich., below Detroit, is the nearest work of defense.

Money statement.

July 1, 1893, balance unexpended		$43, 277. 30
June 30, 1894, amount expended during fiscal year		22, 885. 49
July 1, 1894, balance unexpended		20,391. 81
July 1, 1894, outstanding liabilities	$6, 457. 69	
July 1, 1894, amount covered by uncompleted contracts	9, 438. 70	
		15, 896. 39
July 1, 1894, balance available		4, 495. 42
Amount that can be profitably expended in fiscal year ending June 30, 1896		100, 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Sandusky, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts:	Tons.
Fish	2, 365
Iron ore	4, 100
Lumber	125, 000
Sand	56, 000
Stone	67, 539
Total	255, 004

Shipments:	Tons.
Coal	169, 276
Total freight tonnage for 1893	424, 280
Total freight tonnage for 1892	385, 661
Increase	38, 619

Shipping.	Number.	Tonnage.
Vessels entering	3, 913	776, 754
Vessels departing	3, 908	747, 429
Vessels built	1	72

Total registered tonnage for 1893 (vessels entering and departing)	1, 524, 183
Total registered tonnage for 1892 (vessels entering and departing)	1, 423, 746
Increase	100, 437

Draft of largest vessels using harbor, 17 feet.
Depth of water prevents largest vessels from loading to full depth.
No new lines of transportation have been established during the year.

N N 5.

IMPROVEMENT OF SANDUSKY RIVER, OHIO.

The Sandusky River rises in Richland County, Ohio, and empties into the upper end of Sandusky Bay, about 14½ miles by the channel of the bay to Lake Erie.

Fremont, at the head of navigation, 18 miles from the bay, is a city of about 9,000 inhabitants and the market town of a large area.

In 1867 and 1872 appropriations amounting to $30,000 were made for improving the river.

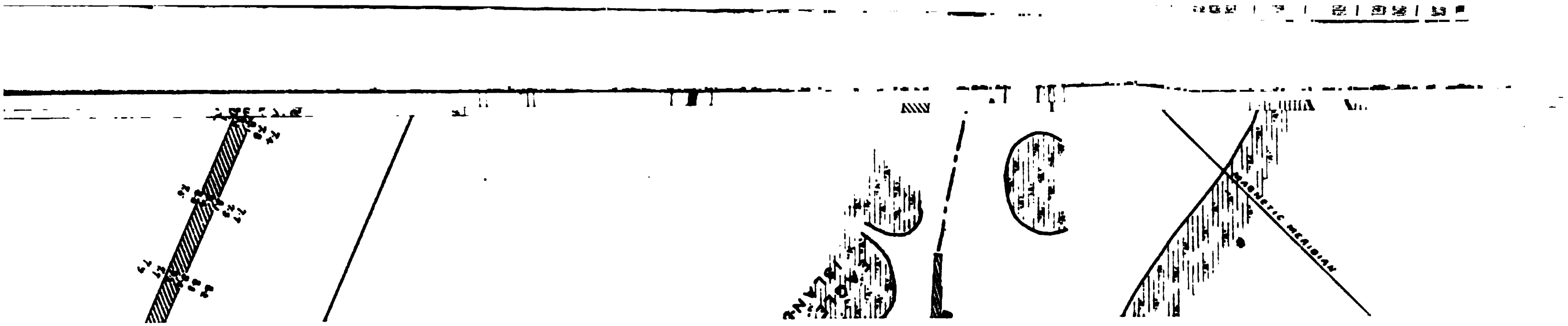
In 1880 a project was adopted for dredging a channel 100 feet wide and 9 feet deep through several bars between Fremont and the depth of 9 feet in Sandusky Bay. The estimated cost was $44,000.

The following appropriations were made after the adoption of the project:

June 14, 1880	$10, 000. 00
March 3, 1881	7, 500. 00
August 2, 1882	4, 000. 00
September 19, 1890	1, 500, 00
July 13, 1892	5, 000. 00
Total	28, 000. 00
Amount expended to June 30, 1893	23, 152. 79
Amount expended in last fiscal year	4, 706. 25

At the beginning of the fiscal year a contract was outstanding with Messrs. Sadler & Allen, of Detroit, Mich., for dredging the channel through the bar at the mouth of the river. The contract had been awarded in connection with dredging at several other places, so that the commencement of dredging was delayed until August 30, 1893. Dredging under the contract was completed October 21, 1893, the total amount removed being 25,569 cubic yards.

The entire length of the channel dredged through the bar is 5,900 feet; of this amount 1,300 feet at the upper end was made 60 feet wide and the remainder 40 feet wide; the material was removed to a depth of 10 feet in order to insure a clear channel of 9 feet depth.


MAGNETIC MERIDIAN

The bar is formed of a very soft mud, which is brought down the river in suspension and deposited at the mouth, where the current is slackened by emptying into the broad waters of the bay.

Owing to the small amount of traffic on the river and its exclusively local character, the U. S. Light-House Establishment does not buoy the channel. For this reason I have had the channel marked by proper stakes and buoys, the work being done, in connection with an examination of the channel, May 25 and 26, 1894.

There is really no commerce on the river in any broad sense of the word. A small amount of lumber is taken up the river from Sandusky for local consumption, and a few picnic and other excursions are made in small steamers at irregular intervals in the summer.

A map of Sandusky River is forwarded to accompany this report; also a report of Mr. William T. Blunt, U. S. assistant engineer.

Fremont, the head of navigation, is in the collection district of Sandusky, Ohio. The nearest light-house is at Cedar Point, the entrance to Sandusky Bay. Fort Wayne, near Detroit, Mich., is the nearest work of defense.

Money statement.

July 1, 1893, balance unexpended	$4,847.21
June 30, 1894, amount expended during fiscal year	4,297.14
July 1, 1894, balance unexpended	550.07
July 1, 1894, outstanding liabilities	409.11
July 1, 1894, balance available	140.96
Amount (estimated) required for completion of existing project Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	16,000.00

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER.

CLEVELAND, OHIO, *June 20, 1894.*

SIR: Herewith I respectfully forward a tracing showing soundings taken at the mouth of Sandusky River, May 26, 1894, together with positions of buoys placed by your orders as a guide to dredged channel.

This channel was dredged in 1893 under contract with Sadler & Allen, of Detroit, Mich., 25,568 cubic yards having been removed by the dredge *Ravenna*, under the inspection of Mr. John Morton. Dredging was begun August 30 and completed October 21, 1893.

By surveys made in 1892 it was found that a narrow channel existed from the mouth of the river to the general bay depth of 8½ feet, a distance of 6,000 feet. The depth was from 7½ to 8 feet. One marked angle existed, and just outside of that was another slight bend with clay banks. Evidently the dredging in the past had followed these bends. The bottom was of very soft marsh mud, overlying stiff clay at about 8½ or 9 feet. An estimate made for basis of contract, assuming the cost to be 20 cents per yard, allowed the removal of about 22,000 yards, and specifications were issued for one cut 30 feet wide to 10 feet depth at mean level through about 6,000 feet length, the balance, if any, to be taken from sides where seemed to be the best advantage. The contract was let to Sadler & Allen for 16 cents, and it was therefore possible to remove 25,568 yards, and on account of liberality of first estimate to dredge the entire length 40 feet wide at bottom, and in addition to make an extra cut around the elbow for a distance of 1,400 feet. In this work the slight bend before mentioned was taken out, so that now the channel is two straight courses, one 4,800 feet long and the other veering 16½ degrees to the southward on entering and 1,200 feet long. Cuts were made to good 10 feet at mean level, and scattered soundings taken after completion, but when time would not allow of an accurate survey, showed the work to have been well done, although the soft mud which abounds there had even then filled in to some extent.

Soundings taken in May, 1894, show a general depth of 9 to 9½ feet, indicating a fill of about 1 foot since dredging was done. While the immediate banks have sloughed in to a slight extent, I can discover no general change, certainly not enough to account for the fill. The conclusion is inevitable as it is reasonable that the fill occurs from the general and continual movement of soft material along the bottom, in which the tendency is to even itself and therefore to fill a cut.

At the so-called mouth of the river its waters reach the bay through a large extent of marsh with several cuts of more or less depth and an entire absence of current except as induced by wind. In fact, there is usually at most a very slight current out as far up as Fremont. The cut most commonly used by boats and probably the deepest is that north of the Eagle islands, where this dredging was done. From the inner end of the dredged cut we find a good 10 to 20 foot channel, with slight interruptions up to the old elevator location near Fremont, 15½ miles. The interruptions consist of several shoal places or bars, as Squaw Island Bar, 1¼ miles; Nigger Bend Bar, 11¼ miles; House Bar, 13 miles, and Whitaker Bar, 13¼ miles from the bay, at all of which there was found 9 feet of water, though often narrow.

The amount of commerce using Sandusky River has not for some years warranted the placing of buoys by the General Government, so that unmarked buoys, stakes, and even slabs have been set in any way to suit the convenience or whims of those using them. By your order I placed, on May 26, eight 4 by 4 inch white pine buoys, dressed and painted their proper color. One red and one black were placed at the outer end of the cut, also one red and one black at the elbow 4,800 feet inside. Between these two points there were placed four red buoys at 1,200, 2,000, 3,150, and 4,100 feet, respectively, from the outer end. In addition to these, there were found two buoys already properly placed but wrongly painted inside the elbow. These as well as about 12 or 15 others around the bends to Squaw Island were painted the proper color. This leaves the channel very well marked.

Very respectfully,

Wm. T. Blunt,
Assistant Engineer.

Lieut. Col. Jared A. Smith,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following statistics for the year 1893 relative to the commerce of Sandusky River, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts: Lumber, laths, shingles, posts, 5,750 tons.

Shipping.	Number.	Tonnage.
Vessels entering	17	2,040
Vessels departing	17	2,040

Total registered tonnage for 1893, 4,080.

N N 6.

IMPROVEMENT OF HURON HARBOR, OHIO.

The Huron River empties into Lake Erie at a point about 10 miles east of Sandusky.

In 1826, when the mouth of the river was closed by a sand bar, a plan of improvement was adopted, consisting of parallel piers 140 feet apart to confine and protect the channel. The plan was modified and extended from time to time as the demands of commerce required.

The latest plan, approved in 1890, consists in extending the piers to the contour of 16 feet depth in the lake.

In 1890 Major Overman made the estimate for piers as follows:

For 120 feet extension of the west pier, at $70 per linear foot	$8,400
For 80 feet extension of the east pier, at $70 per linear foot	5,600
For contingent expenses, say 10 per cent	1,400
Total	15,400

In 1893 a survey showed that the lengths of piers estimated were far too small to reach the lake contour of 16 feet depth on the bar, though the depth of 16 feet in the channel, which has been obtained by dredging, might at times be reached with the lengths given. The estimate was therefore revised in regard to pier lengths, and the prices were placed on the base of the latest contracts.

It was also found necessary to construct the piers much stronger than heretofore, and to place the foundations deeper, owing to the increasing depth required for lake harbors and channels, and to the very heavily loaded vessels which frequently come against the piers with sufficient force to break away the superstructure unless it is heavy and well secured.

In 1891 the west pier was extended 120 feet, and in 1893 it was further extended 40 feet, and the east pier was extended 80 feet.

The distances then remaining to reach the lake contour of 16 feet on the bar in 1893 were estimated as follows:

East pier, 640 feet, west pier, 600 feet, 1,240 feet, at $92	$114,080
Contingencies, less than 10 per cent	10,920
Total	125,000

The amount expended upon the 240 feet of pier built since 1890 was as follows:

Contract price of 120 feet in 1891	$8,403.22
Contract price of 120 feet in 1893	9,968.14
Contingencies, nearly 10 per cent	1,628.64
Total	20,000.00

The latest contract price, exclusive of superintendence and all contingencies, made the pier cost about $83.07 per linear foot instead of $92 as estimated, but in such constructions there are many contingencies to be provided for besides merely engineering, superintendence, and office expenses.

In case of a severe storm after a crib has been sunk and filled, the loss of stone or other injury, which is sure to result, must be replaced or repaired at an additional expense to the United States, so that it is not prudent at present to reduce the estimate of cost per foot for future work.

Previous to 1890 there had been 22 appropriations, commencing with 1826 and concluding with 1888, for improving Huron Harbor, the aggregate of appropriations and expenditures being $123,273.71.

Since the adoption of the present project for extension of piers to lake-contour of 16 feet depth, the following appropriations have been made:

By act of September 19, 1890	$16,000.00
By act of July 13, 1892	15,000.00
Total	31,000.00
Amount of above appropriations applied to extension of piers	20,000.00
Amount of same applied to maintenance of channel by repairs to piers and dredging	9,839.88
Balance on hand for repairs and dredging	1,160.12
The total expenditures to June 30, 1893, on present project, including liabilities, were	16,352.97
Amount incurred in last fiscal year	13,486.91

At the end of the last fiscal year a contract was outstanding with Mr. Q. Gillmore, of Lorain, Ohio, for extending east pier 80 feet and west pier 40 feet. Work under the contract was commenced June 6, and completed September 19, 1893, in a thoroughly satisfactory manner.

A contract was outstanding with Messrs. Sadler and Allen, of Detroit, Mich., for dredging through the bar. The contract was made in connection with similar work at several other places in that part of the lake; the amount was contingent upon the formation of the bar in the freshets of the spring of 1893. The freshets of that spring were of an unusual kind, and at Huron as well as several other places the channel over the bar was made deeper instead of more shallow. As a result, no dredging has been imperatively needed at this point under the contract. The channel has, however, become somewhat filled, and the dredge was therefore taken to that work, on the completion of work at Port Clinton, late in June. Dredging will be commenced July 1, 1894.

On the 1st of April, 1894, repairs were commenced on the superstructure of west pier; work was continued until June 16, 1893.

Commencing at a point 205 feet outside the pile protection at shore line, and extending 180 feet outward, the superstructure has been rebuilt 10 feet wide and 6 feet high. Again commencing at a point 606 feet from the pile protection at shore line, and extending outward 109 feet, 12 feet wide and 6 feet high, the superstructure has been taken away and rebuilt entire.

This work involved removing and replacing all the old stone, straightening and redriving a large part of the old iron, and doing much other work which would not be required in a new work.

In making this repair the materials and labor were as follows:

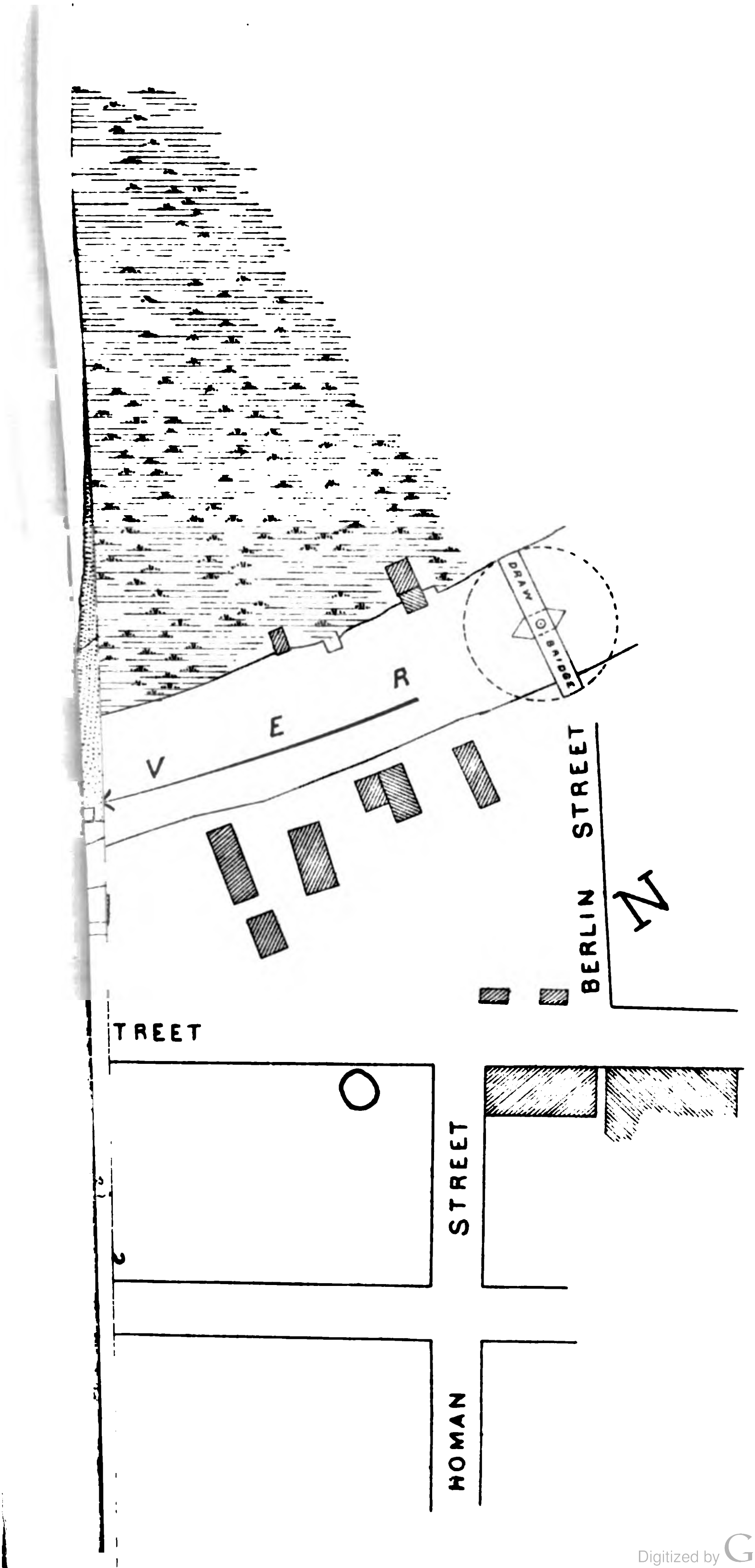
64,100 feet B. M. pine timber	$1,366.88
Switching cars	10.00
10 cords stone	50.00
8,490 pounds bolts	193.57
800 pounds spikes	22.00
Hire of scow	126.00
Labor and superintendence	642.40
Total, excluding engineering and office expenses	2,410.85

As before explained, these materials did not cover the entire work, because all the stone in the superstructure was twice handled and some of the old iron was redriven. The new material put in the repairs at the contract price paid for extending the piers would amount to $2,459.15, which is more than the cost of the repair, including removal and handling of old material. The contract necessitates an inspector, which adds to the cost. The account for repair included all superintendence. This comparison is made to show that the method of doing the work was more economical and advantageous to the United States than the method by contract. Some further repairs to piers are still necessary.

No work has thus far been done under the contract for dredging. The amount to be dredged under contract which was outstanding at beginning of fiscal year was contingent upon the formation of the bar outside the piers. The channel has remained in an unusually good condition, so that no dredging has thus far been undertaken.

A map of Huron Harbor, showing present conditions and the proposed extension of piers, is forwarded to accompany this report.

Huron Harbor is in the collection district of Sandusky, Ohio. Fort Wayne, Mich., about 70 miles distant, is the nearest work of defense. There is a fixed white light of the fourth order on the outer end of the west pier.



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Money statement.

y 1, 1893, balance unexpended	$14,772.03
ne 30, 1894, amount expended during fiscal year	13,611.91
ly 1, 1894, balance unexpended	1,160.12
ly 1, 1894, outstanding liabilities	16.67
ly 1, 1894, balance available	1,143.45
Amount (estimated) required for completion of existing project	125,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Huron, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.
RECEIPTS.	
Iron ore	138,710
Lumber, railroad ties, etc	2,134
Total	140,844
SHIPMENTS.	
Coal	284,198

Total freight tonnage for 1893	425,032
Total freight tonnage for 1892	76,039
Increase	348,993

Shipping.	No.	Tonnage.
Vessels entering	137	112,445
Vessels departing	145	116,502

Total registered tonnage for 1893	228,947
Total registered tonnage for 1892	183,209
Increase	45,738

Draft of largest vessel using harbor, 16¼ feet.
Largest vessels load to full depth.
No new vessel lines established during the year.

N N 7.

IMPROVEMENT OF VERMILLION HARBOR, OHIO.

The Vermillion River rises in the northern part of Ohio, and empties into Lake Erie about 20 miles to the eastward of Sandusky.

In 1836 there was less than 2 feet of water over the bar at the mouth of the river, and a project was adopted to extend parallel piers 125 feet apart over the bar into the lake. This was amended from time to time until the piers were extended to a depth of 12 feet in the lake in the spring of 1874. The east pier was then 1,075 feet and the west pier 1,125 feet in length. In the same year a project was adopted to remove rock and other material between the piers and into the lake to afford a depth of 14 feet over a width of 100 feet. This was completed in 1879.

The work thus far was carried on under eleven appropriations, from 1836 to 1878, inclusive, amounting in the aggregate to $113,701.28.

Since that time the channel depth has varied from time to time, but it is rarely less than 12 feet at mean lake level.

Since 1879 all expenditures have been for repairs.

There is no project for further improvement, because the present commerce of the place is very small and is not growing. It is, however, considered advisable to keep the piers in repair.

In the summer of 1892 a part of the superstructure of the piers was rebuilt under the appropriations of September 19, 1890, and July 13, 1892.

Since the completion of the improvement in 1879 the following appropriations have been made and expended for repairs:

June 14, 1880	$2,000
March 3, 1881	2,000
August 2, 1882	3,000
August 5, 1886	3,000
August 11, 1888	1,000
September 19, 1890	2,000
July 13, 1892	2,000
Total	15,000

It is recommended that the balance estimated to complete project be appropriated in a single sum, to be applied to necessary repairs to the piers.

Vermillion Harbor is in the collection district of Sandusky, Ohio. There is a fixed light of the fifth order on the west pier. Fort Wayne, Mich., 80 miles distant, is the nearest work of defense.

Money statement.

Amount (estimated) required for completion of existing project	$6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Vermillion, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.
RECEIPTS.	
Fish	2,000
Lumber, etc	666
Total	2,666
SHIPMENTS.	
Fish	1,400
Timber	38
Gravel	200
Total	1,638

Total freight tonnage for 1893	4,304
Total freight tonnage for 1892	5,350
Decrease	1,046

Shipping.	Number.	Tonnage.
Vessels entering	46	7,500
Vessels departing	50	7,600
Vessels built	*2	50

* Tugs.

Total registered tonnage for 1893 (vessels entering and departing)	15,100

Draft of largest vessels using harbor, 11½ feet. Largest vessels load to full depth. No new vessel lines established during the year.

N N 8.

IMPROVEMENT OF BLACK RIVER HARBOR, OHIO.

This harbor is in the township and city of Lorain, where the Black River empties into Lake Erie. In its natural condition the river had a depth of but about 3 feet on the bar at its mouth.

In 1828 an improvement was undertaken by confining the channel between parallel piers extending over the bar into the lake. The project was modified and extended from time to time as the demands of commerce increased.

In 1891 the officer in charge of the improvement submitted a recommendation to extend the parallel piers to a depth of 17 feet in the lake.

The project was approved in 1893, the estimated cost being as follows:

Extending piers to a depth of 17 feet in the lake.

Two piers, 280 feet each, 560 linear feet, at $91.10	$51,016
Contingencies of all kinds, less than 10 per cent	4,984
Total	56,000

To obtain the estimated amount required for completion of project to submit with Annual Report for 1893, the amount of $10,000, which was proposed to be expended on the project from appropriation of July 13, 1892, was deducted from estimate of total cost, leaving $46,000.

The amount of pier constructed was, however, less than was anticipated, owing to the necessity for more extended repairs to old pier.

Previous to the adoption of the latest project there had been twenty-six appropriations for improving Black River Harbor, Ohio, the aggregate amount being $232,204.77. As a result the piers had been extended practically to a depth of 16 feet in the lake, and a channel which ordinarily exceeded 16 feet had been obtained between the piers. Outside the piers the depth is generally greater than 16 feet, but in spring storms and freshets a bar is usually formed just at the entrance to channel between piers. At such times dredging is required.

The extension of piers will to some extent prevent the formation of a bar at the entrance and may, perhaps, increase the depth between piers. The crib work is 24 feet wide, and rests upon a foundation of hard material dredged to a depth of 18 feet. The first seventeen courses of the crib are of hemlock timber and the eighteenth course, with eight courses of superstructure, are of pine.

The appropriation of $20,000 by act of July 13, 1892, was in excess of the amount estimated to complete the piers to a depth of 16 feet in the lake, and it was therefore understood to be an approval of the recommendation previously submitted to extend piers to 17 feet depth. The project and estimate was therefore submitted to the Chief of Engineers, and was approved.

On this project the amount expended to June 30, 1893, including liabilities, was	$1,800.78
Expended in last fiscal year	17,972.29
Total on project to June 30, 1894	19,773.07

At the beginning of the fiscal year two contracts were outstanding; the first with Mr. John Stang, of Lorain, Ohio, for repairs and extension of piers; the second with Messrs. Sadler & Allen, of Detroit, Mich., for dredging a channel through the bar at outer end of piers. The latter contract was a part of a contract covering similar work in several other places, and the amount to be dredged was contingent upon the formation of the bar.

In November, 1892, the bar was dredged and a good channel was made. The freshets in the spring of 1893 were unusual in character and extent. One remarkable feature at Black River, as well as at other similar harbors on Lake Erie, was that the streams were very much swollen by heavy rains and melting snow, while the ice still remained between the piers and in the lake to a considerable distance outside the piers.

Such a condition necessarily affects the velocity curves of the current in the channel, and the result was a greatly increased scour and consequent depth.

Conditions favorable to forming a bar at the end of piers have not since occurred to a sufficient extent to make any dredging specially necessary.

Work under the contract for repairs and extension of piers was commenced July 10, and completed November 29, 1893.

The part of old east pier near the shore had been constructed many years ago and rested upon what was then the natural bottom of the lake adjacent to the channel. The gradual deepening of the channel, and especially the deepening by dredging in the summer of 1891, caused the material to slide from under the cribs into the channel, so that a section 120 feet long settled and tipped toward the channel to such an extent that the only practicable method of repair was to rebuild it entirely.

It was hoped to use the old cribs, and by building them higher to replace them in the line of the pier on a foundation dredged to a depth of 16 feet below mean lake level. When the cribs were examined, however, they were found to be in such bad condition that they could not even be removed entire. The lower courses were of round timber, and although the timber of the cribs was sound, it was badly worn; near the surface of the water it had been badly worn by ice, and throughout the cribs the effect of the water being forced back and forth through the joints had been to wear away the timber to a remarkable degree.

It is probable that the wearing may have been increased by the presence of sand and other material in suspension in the water, so that its effect would be akin to that of an ordinary sand blast in air. At the ends of the cribs, where end timbers were "halved" into the side sticks, and at all places where the cross-ties dovetailed into side timbers, the joints were worn away so as to make the clear spaces from 1 to 2 inches wide, and sometimes even as great as 3 inches. In this respect it was interesting to note that elm timber, of which much had been used, was worn away to a much greater extent than any other timber used, including principally hemlock and pine, with a small amount of oak.

No effort was therefore made to save the cribs, and they were removed in the cheapest manner possible, by dredging.

Four cribs, a length of 120 feet, were thus taken out and the bottom was dredged evenly to a depth of 16 feet. The material was hard and somewhat difficult to dredge, and it involved the necessity of removing a substantial row of piles with waling pieces and capping which had been built with a view to securing the pier, besides the great inconvenience of reaching and handling the dredged material in such a place.

After the opening of 120 feet had been partially refilled with entirely new crib work, ballasted with stone, a severe northeast storm tore away an additional crib of 30 feet of the old pier outside of the part removed and adjacent to it; the part carried away being a single crib, the end of opening below water was left square to build against, but above water the superstructure was broken and slivered so that much extra work was required to put it in good condition. The repair of the entire opening, amounting to 151½ linear feet of crib work 14 feet wide, with superstructure 6 feet high, was completed in October.

It had been expected to extend the west pier 80 feet and the east pier, 40 feet, but the unexpected increase in repairs, which were imperative, compelled a reduction in the other part of the work, so that the extension was limited to 40 feet on each pier.

Much trouble has been heretofore experienced by the breaking in of pier heads through accidental collisions of vessels entering the harbor. For this reason a special design has been made for pier heads by which the angles are specially strong, banded with iron, and the head has at least 2 feet of solid timber covered with oak plank 4 inches thick. The contract, including repairs, extension, and pier heads, was completed November 29, 1893.

In addition to the repairs of east pier, repairs were made to the west pier in several places, besides refilling the outer end, which had been emptied of stone by the storms.

The statement of work accomplished under the appropriation of $20,000, by act of July 13, 1892, is therefore as follows:

Dredging channel in November, 1892	$866.25
Extending piers 80 feet	7,751.70
Rebuilding 151½ feet of east pier	8,681.42
Repairing west pier	801.50
Superintendence, office, and contingencies of all kinds, including surveys.	1,672.20
Balance on hand	226.93
Total	20,000.00

The cost of 80 feet of crib extension, including contingencies, was therefore $8,381.78, or $104.77 per linear foot. This cost, however, includes two pier heads and the necessary connections with old piers, which is an illustration of one of the reasons why such work costs more when carried on under small appropriations. The estimated cost for the whole work was $100 per linear foot.

As only a little more than $8,000 of the last appropriation was expended upon the project of pier extension, instead of $10,000, on which the estimate for completion was based, as before explained, it may be necessary to modify that estimate in future, but it is not thought necessary at this time.

A map of the mouth of Black River, showing the project and condition at time of latest survey, is submitted to accompany and explain this report.

On the 28th of May the steamer *Mariposa*, in entering the harbor, collided with the outer end of the east pier and tore away the northeast corner of the pier, extending about half the width and a somewhat longer distance on the side. The owners have made arrangements to have the pier properly repaired at their own expense.

The Black River, near Lorain, has recently been selected as the water communication to a new establishment for the manufacture of steel. The matter seems to have taken a definite shape, and it will probably add largely to the future commerce of the harbor.

It should be noted that the cost of project for improvement does not include expense of maintaining channel by annual dredging through the bar, nor does it include maintenance of old superstructure by repairs. These expenses can not be estimated as part of a definite plan, but must be incurred from year to year as may be necessary from available funds, leaving the balance to be applied upon the project for extension of piers.

Black River is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order at the outer end of the west pier. The nearest work of defense is Fort Wayne, Mich., 80 miles distant.

Money statement.

July 1, 1893, balance unexpended	$18,215.89
June 30, 1894, amount expended during fiscal year	17,988.96
July 1, 1894, balance unexpended	226.93
Amount (estimated) required for completion of existing project	46,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	46,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at mouth of Black River, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		**SHIPMENTS**—continued.	
Iron ore	171,562	Flour	6,226
Lumber, shingles, laths, etc	7,135	Stone	3,653
Stone	2,134	Sugar	2,054
Coal	100	Grain, meats, etc	628
Miscellaneous	45	Lumber	325
		Brick	180
Total	180,976	Machinery	19
		Miscellaneous merchandise	67.875
SHIPMENTS.			
Coal	550,194	Total	645.527
Oil	14,373		

Total freight tonnage for 1893	826,503
Total freight tonnage for 1892	231.434
Increase	595,069

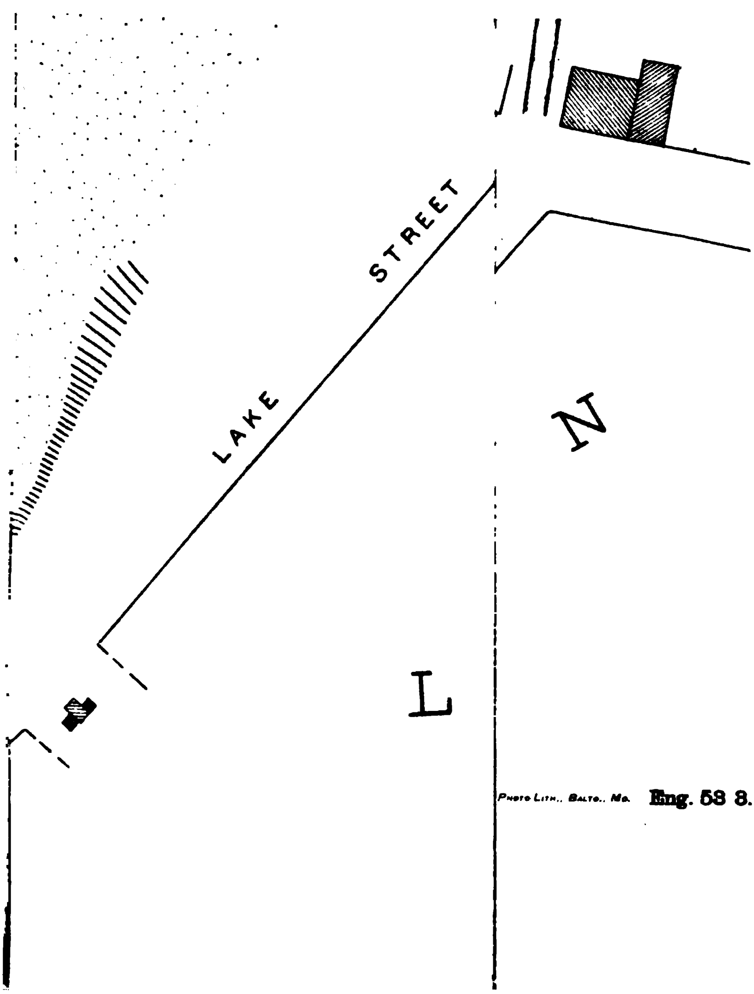


PHOTO LITH., BALTO., MD. Eng. 53 8.

Shipping.	Number.	Tonnage.
Vessels entering	220	621,677
Vessels departing	293	202,276

Total registered tonnage for 1893	823,953
Total registered tonnage for 1892	548,234
Increase	275,719

Draft of largest vessels using harbor, 16 feet.
Largest vessels load to full depth.
No new vessel lines established during the year.

N N 9.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

In 1825 the mouth of the Cuyahoga River was obstructed by a long sand bar, the channel was crooked, and the depth of water over the bar was but about 3 feet.

A plan of improvement was then adopted to straighten and deepen the river at its mouth by means of piers on each side to confine and direct the channel over the bar. The plan was modified and extended from time to time until 1869, when it was completed. The work involved considerable expense for maintenance by dredging and the repairs of piers.

Four appropriations, 1870 to 1874, inclusive, were subsequently expended in rebuilding parts of the west pier with stone and in repairs and dredging.

The total amount appropriated and expended on this improvement until 1875 was	$346,881.61

In 1875 Congress made an appropriation for a breakwater in 5 fathoms of water to protect the commerce of Cleveland. A plan was therefore made for an outer harbor as a refuge and anchorage.

The original plan has been amended, and now consists of two breakwaters.

Amount expended from adoption of present project in 1875 to June 30, 1893	$1,197,701.61
Amount incurred in last fiscal year	70,790.33

The following appropriations have been made since adoption of the project:

March 3, 1875	$50,000	August 5, 1884	$100,000
August 14, 1876	50,000	August 5, 1886	93,750
August 14, 1876 (repair of pier)	8,000	August 11, 1888	100,000
June 18, 1878	100,000	September 19, 1890	75,000
March 3, 1879	100,000	July 13, 1892	100,000
June 14, 1880	125,000		
March 3, 1881	200,000	Total	1,276,750
August 2, 1882	175,000		

NOTE.—About $50,000 of this amount has been expended in maintenance of the old piers and channel.

A map is forwarded to accompany and explain this report. Upon the map the complete project is shown, and the years in which the various parts have been constructed.

The length of shore arm given in last Annual Report was incorrect, through a typographical error; the correct length is 3,130 feet. The length of spur on west breakwater was also incorrectly given; the correct length is 100 feet.

At the beginning of the fiscal year a contract was outstanding with Messrs. Sadler and Allen, of Detroit, Mich., for dredging in the harbor, the necessity for which was explained in the last Annual Report.

The dredging, which had been commenced May 7, 1893, was carried on continuously until November 15, 1893, and was then suspended for the winter. Dredging was resumed March 30, and continued until April 13, 1894, when the contract was completed. The amount of material dredged and removed during the fiscal year was 121,796 cubic yards, and the total under the contract was 142,998 cubic yards, measured in scows. The area, dredged to a depth of about 19 feet, and nowhere less than 18 feet, is shown in shaded lines upon the map.

The material dredged was towed to a point in the lake east of the line of Case avenue prolonged, a distance of about 2 miles. It has been considered necessary to tow the material to a place at least as distant as the one mentioned in order to prevent possibility of injury to navigation in the harbor or its approaches.

In this connection attention is invited to the fact that the city of Cleveland has for several years had dredging done in the river channel by contract, and is still doing the same, the contract requiring the material dredged to be towed eastward and dumped in the lake not farther west than the prolongation of Erie street.

Individuals having dredging done have followed the example of the city, and as a result a large amount of material has been dumped and is still being dumped entirely within the limits of the area to be included in the harbor which the United States is building at great expense for the benefit of Cleveland commerce.

The shoal which has been formed by the city dumping is distinctly shown upon the map accompanying this report. In many cases, indeed, the material is not towed as far as Erie street, but has been dumped at points much nearer the piers. In a few instances information has been lodged with the U. S. attorney of such dumping, under the provisions of section 6 of the river and harbor act approved September 19, 1890, but it has been found exceedingly difficult to secure a conviction, although the facts are well known; and in cases of conviction the penalties have been made less than it would cost the United States to remove the material dumped in the single cases on which conviction was obtained. This remark is intended to apply to cases at Toledo and at Cleveland harbors.

The most effective remedy would perhaps be an injunction from the U. S. court forbidding all parties owning or controlling dredging plant on this lake from dumping material elsewhere than in places authorized by the Secretary of War.

At the beginning of the fiscal year a contract was outstanding for constructing 450 feet of breakwater in extending the protection eastward. Work, which had been commenced April 10, was continued until November 9, 1893, when it was completed.

The breakwater is constructed upon a foundation of riprap stone which is designed to be 6 feet deep after it has settled compactly together. For this reason it is made about 1 foot higher when dumped into place. The width of the riprap foundation is 60 feet on top, and the slopes are as nearly as practicable 1 on 2. The middle line of foundation coincides with the middle of breakwater.

The cribs of the breakwater are 32 feet wide, and an arrangement is given to the bottom pieces by which the base has a width of 34 feet. A drawing is submitted with this report showing the details of construction of the cribs and superstructure. The design shown has only been employed for the work under the last contract. The water at the site is 31 to 32 feet deep, and the bottom material is so soft that a mooring pile was driven down 12 feet or more with a single blow of the hammer of an ordinary pile-driver. The extremely soft condition of the bottom was not known until work was commenced under the contract, and some apprehension was felt regarding the stability of the structure.

The crib work, as constructed, bore upon three timbers under each of the outside longitudinal walls and a single timber under the middle longitudinal wall, besides the support received from other parts of the crib. The plan has shown such excellent results that the number of timbers for bearings have been increased to four under the outer and inner walls, and three under the middle wall.

The inspector, who has served for many years as superintendent of construction of harbor work, states that formerly, when the cribs had been brought to a bearing on the foundations and the process of filling with stone commenced, the cribs commenced settling into the foundation of loose stone, and before the superstructure was put on, the cribs had generally settled about 2 feet, and often very unevenly. In these cribs the settling into foundations did not exceed one-half that which occurred with the former cribs having no extra bearing timbers.

The superstructure of all of the east breakwater has been constructed with a parapet on the lake side, 12 courses of timber (approximately about 12 feet) above mean lake level; the half on the harbor side has been built only 6 courses high.

On the 29th of June, 1894, Mr. F. S. Burrowes, assistant engineer, made an examination of the elevations of top of east breakwater with the following result, viz:

> One thousand nine hundred and ninety-one and five-tenths feet of parapet on east breakwater averages 10.05 feet above mean lake level, varying from 9 feet to 11.3 feet above mean lake level. Four hundred and seventy-eight and five-tenths feet of parapet on east breakwater, built in 1893, averages 11.65 feet above mean lake level, varying from 11.1 feet to 12.4 feet above mean lake level.

The highest part of the parapet, built in 1893, is where it was racked back over the old work at the junction with the new, and was, therefore, where the foundations had fully settled. The extreme east end is 12.3 feet high and the middle sags to 11.1 feet.

No definite measures have heretofore been taken to show the settlement in different years, but it is apparently very small after the first year. The above observations show that the breakwater built last year has, since completion, settled only about one-third as much as the part previously built. This is believed to be largely due to the greater bearing of the cribs upon the riprap foundation, and for this reason the bearing upon foundation has been increased in plan for future construction as shown in drawings.

The bolting in the cribs is in general of round rolled American iron, 1⅛ inches in diameter. As a timber can be pulled off from the bolt much easier than the bolt can be pulled up through the timber, the bolts have been upset and swaged at top to form a kind of button-head. The point of bolt is simply a small bevel to remove the sharp edge where the iron is cut so that it will not tear the wood fiber when being driven.

Bolts are all driven perpendicular to the surfaces and joints instead of on an angle as heretofore, because the work is more cheaply done;

the timbers can be drawn together more firmly, and it is evident that the force which would be required to produce the initial movement which would result in a separation of the cribs, is decreased with the increase of the angle of the bolt from the normal.

Another feature in which this part of the breakwater differs from that which preceded is in the introduction of corner posts. These not only form a prime factor in holding the timbers together, but they greatly stiffen the cribs and make them capable of carrying a superstructure of concrete or other masonry, should it be found desirable when the timber above water has become decayed.

A statement of the expenditure of the appropriation of $100,000 by act of July 13, 1892, may be made, as follows:

July 1, 1892, balance available	$1,397.88
Amount appropriated July 13, 1892	100,000.00
Total	101,397.88
Dredging in November, 1892	1,432.71
451½ feet extension of east breakwater	70,549.94
Dredging under contract	20,019.72
Repairing breakwater	4,209.11
Surveys of harbor, 1892 and 1893	425.49
Contingencies of superintendence, examinations, office, etc	4,574.01
Balance available	186.90
Total	101,397.88

The anchorage in the harbor of refuge west of the river channel is now accessible to the largest vessels which come to the port of Cleveland, and the room is ample for all present needs. There is, therefore, no pressing necessity for the immediate completion of the breakwater as proposed.

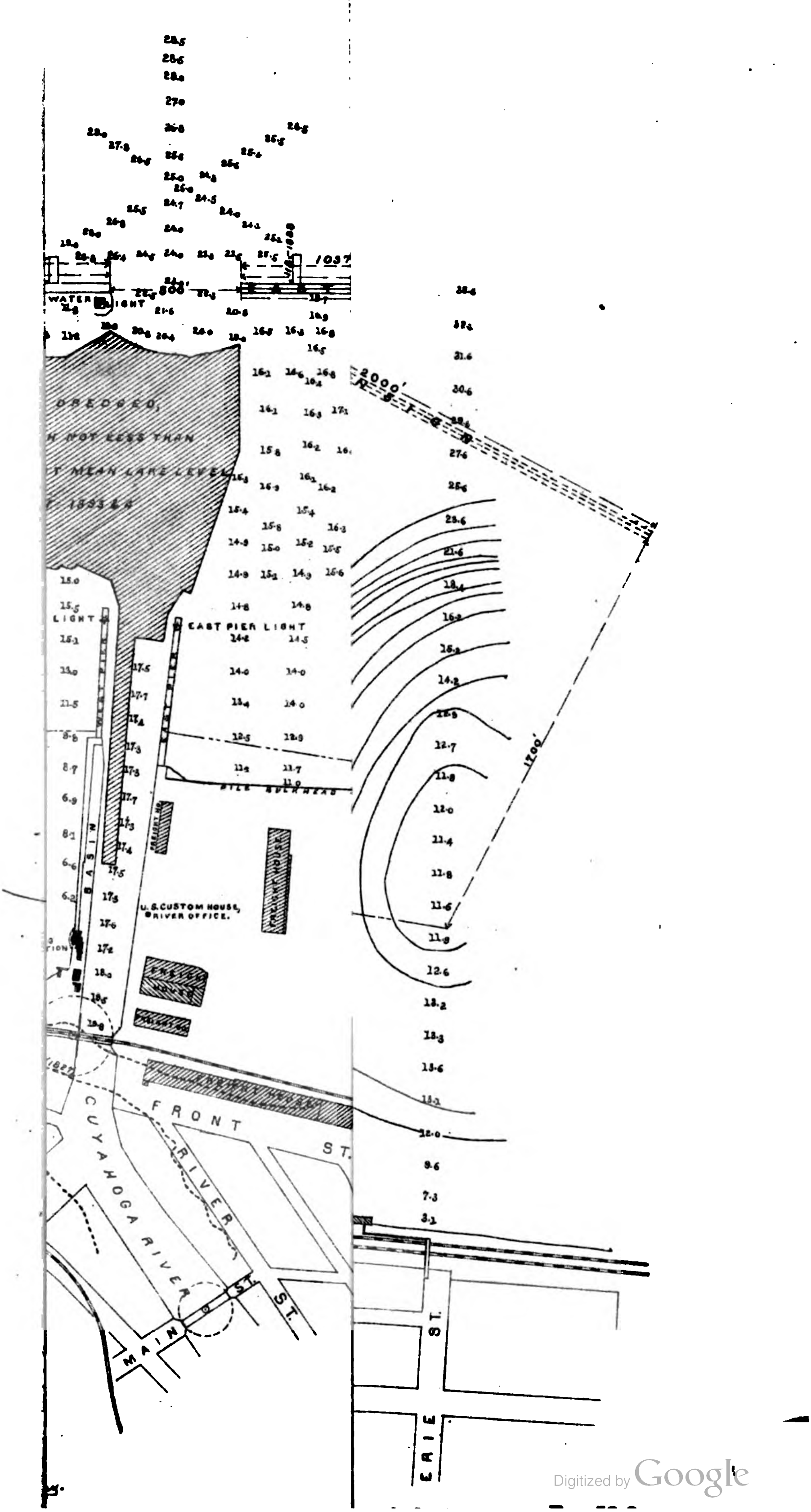
Part of the shore arm of the west breakwater was constructed in 1876, other parts in 1878, 1879, and 1881. Eight hundred and fifty feet of the west end of breakwater proper was built in 1881. All the real strength of pine timber above water in a pier is gone in about twelve years, though it may under favorable circumstances hold several years longer and sometimes remain in place until entirely rotted out, which may require twenty years or more.

Should the superstructure of a part of the breakwater be carried away in a storm, the crib work below water would almost surely follow, because when the cribs are exposed in heavy storms the stone is taken out by the action of the seas, and the woodwork is left with too little ballast to hold it in position.

It is, therefore, very important that the old superstructure should be rebuilt before it is too far gone to decay to withstand the force of storms. It will be seen in the statement of expenditures that more than $4,000 of the last appropriation was expended in repairs to the breakwater; the repairs consisted almost entirely in replacing planking and deck stringers which had been broken away in winter. A small opening once made sometimes becomes the means of letting in forces which bring destruction to a large part.

A superstructure of concrete masonry is recommended as the cheapest which can be made of a reasonably permanent character, though it may probably involve the necessity of strengthening the outer walls of the cribs below water level.

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There is a beacon on the outer end of each pier, and a beacon with flash light and fog whistle on the independent crib just inside the east end of the lake arm of the breakwater. The nearest work of defense is Fort Wayne, Mich., 110 miles distant.



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500'
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NOT LESS THAN
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2000'
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FREIGHT HOUSE
U. S. CUSTOM HOUSE,
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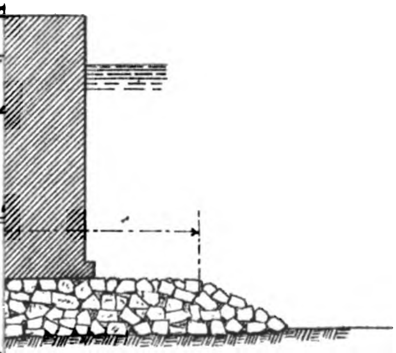

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To accompany annu
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Money statement.

July 1, 1893, balance unexpended	$88,141.49	
Deposited to credit of appropriation	*162.71	
		$88,304.20
June 30, 1894, amount expended during fiscal year		88,117.30
July 1, 1894, balance unexpended		186.90
Amount (estimated) required for completion of existing project		494,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		200,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Cleveland, Ohio, were compiled from information furnished by the collector of customs and others:

DOMESTIC.

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Iron ore	1,265,603	Coal	1,348,273
Railroad ties, posts, etc	849,281	Iron and steel	53,900
Lumber	250,977	Nails and spikes	24,474
Stone	74,123	Lumber	2,934
Iron	25,567	Brick and sewer pipe	4,550
Shingles, laths, etc	19,727	Wire	3,823
Plaster, lime, and cement	9,338	Glass, crockery, and stoneware	551
Flour	5,654	Merchandise	14,284
Grain and hay	2,412	Miscellaneous	965
Fish	1,455		
Potatoes	498	Total	1,453,754
General merchandise	46,056		
Miscellaneous	429		
Total	2,551,120		

FOREIGN.

RECEIPTS.		SHIPMENTS.	
Lumber	2,133	Coal	174,384
Roofing gravel	1,903	Oil	2,234
Salt	1,413	Fire brick and fire clay	1,576
Fish	553	Flour	590
Laths	110	Iron	33
Miscellaneous	88	Miscellaneous	31
Total	6,200	Total	178,848

Total freight tonnage for 1893	4,189,922
Total freight tonnage for 1892	7,060,791
Decrease	2,870,869

Shipping.	Number.	Tonnage.
Vessels entering	3,071	1,980,516
Vessels departing	3,173	2,052,170
Vessels built	6	6,512.15

Total registered tonnage for 1893 (vessels entering and departing)	4,032,686
Total registered tonnage for 1892 (vessels entering and departing)	4,854,119
Decrease	811,433

Draft of largest vessels using harbor, 16½ feet.

Largest vessels do not load to full depth.

New lines of transportation were established as follows, viz: The Vessel Owners' Towing Company, The Cleveland and Buffalo Transit Company, The Ohio Transportation Company, The Cuyahoga Transit Company, The Corrigan Transit Company, The Cleveland Sand and Gravel Company.

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* During fiscal year ending June 30, 1894.

N N 10.

IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

The harbor of Fairport is near the mouth of the Grand River, Ohio, which is navigable for some distance from the lake.

In 1825 the sand bar across the mouth was so hard and dry in the summer that teams could be driven across. In that year a plan was adopted for improving the harbor by the method of parallel piers to confine and protect the channel. The plans have been modified and extended from time to time until 1890, when the latest project was adopted providing for extending the parallel piers to a depth of 18 feet in the lake. The widths between piers were planned to be 200 feet, but owing to imperfections in construction and alignment, and the movement caused by storms, the general width between piers is but 185 feet, though in a few places it is about 195 feet.

At the time the latest project was adopted the channel depth between piers was 16 feet and the depth over the bar 15½ feet. The necessity for an increase of depth was stated as follows:

> Fairport Harbor, Ohio, is now the third harbor on the list of Lake Erie harbors in order of amount of ore received and coal shipped, and the amount of this commerce bids fair to increase still more as other railroad companies are preparing to build to said harbor.

The project and estimated cost of the extension, as modified and approved in October, 1892, is as follows:

For two parallel piers, each 1,060 feet long, 2,120 linear feet, at $100 per foot	$212,000

The cost of dredging the channel to a depth of 18 feet, if needed but once, would be a simple matter to estimate, but when needed to a greater or less extent every year as a result of irregularly recurring conditions in the river and in the lake, it becomes rather a question of maintenance than of extending and completing a definite plan of improvement, and the cost of dredging, as well as of repairing the piers, is therefore not included in the project for extending the piers.

It is not practicable to make a definite estimate for dredging and repairs which shall fully and finally complete all that will be needed. They are more or less necessities of each year, and when imperatively needed must be completed as far as practicable with funds which may be available, leaving the balance to carry on the project for extending the improvement.

This explanation seems necessary for the reason that previous to 1892 the method had not been employed in this district, and as a result the estimates for completion of piers were reduced by the full amount of appropriations, some part of which, and sometimes even all of which, had been expended for repairs and dredging.

The entire amount expended from 1825 to adoption of present project in 1892 was	$319,503.08
Amount expended on present project to June 30, 1893, including liabilities	3,946.54
Amount expended in last fiscal year	25,607.39

At the beginning of the fiscal year work was in progress, dredging under contract with Messrs. Sadler & Allen, of Detroit, Mich.; this was completed July 7, 1893. The amount dredged in July was 2,263 cubic yards, and the amount under the contract, which was commenced June 6, was 10,211 cubic yards. The channel over the bar was dredged to a depth of 18 feet.

A contract was also outstanding at the beginning of the fiscal year with Mr. James B. Donnelly, of Buffalo, N. Y., for constructing an extension to east and west piers. Work under the contract was commenced June 12 and completed November 30, 1893.

The east pier was extended 120 feet and the west pier 160 feet. The pier is of the same type as that constructed at Ashtabula and Conneaut, shown on drawing with report for Conneaut Harbor. The piers are 24 feet wide, superstructure 8 feet above mean lake level, and the cribs are 20 feet deep, upon a foundation of stone in a trench dredged to a depth of 22 feet or more. The foundation is of large stone, projecting 4 feet outside the crib, and the spaces between stone are filled with small stone.

The foundation under the riprap stone is of sand, and much the same difficulty was experienced by the cribs tipping and moving in the October storm as is described in the report for Conneaut Harbor. It is proposed in future to adopt the new type of crib, designed for situations on sand bottom and shown in drawing with report for Conneaut Harbor.

The entire appropriation of July 13, 1892, may be accounted for as follows:

July 1, 1892, balance	$1,370.45
Appropriated July 13, 1892	35,000.00
Total available	36,370.45
Expended for dredging the bar November, 1892	600.00
Expended for dredging the bar June and July, 1893	2,012.20
Expended for extending piers 280 linear feet	24,055.61
For superintendence, surveys, and contingencies of all kinds	2,856.12
Balance on hand June 30, 1894	6,816.52
Total	36,370.45

The available balance is held to meet any emergencies which may arise requiring an expenditure for repairs or for deepening the channel.

The channel during the past year has been unusually deep, and in the spring of 1894 there were no conditions which caused the formation of a bar to a sufficient extent to cause inconvenience to navigation.

The condition of the piers outside of the shore line is fairly good, but inside the shore line, especially on the east side, the piers are in very bad condition. The pier for a length of several hundred feet on the east side is in such bad condition that it should be rebuilt.

In order to fully ascertain the condition of the piers, and also to obtain the information necessary for a report upon the occupancy of the pier by a transportation company which had obtained a lease of the pier and after one year had refused to make further payments, I directed Mr. F. S. Burrowes, U. S. assistant engineer, to make an examination and survey of the harbor and piers in November, 1893.

My report and recommendation to the Chief of Engineers was submitted under date of March 14, 1894, and action was taken thereon as follows:

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, March 14, 1894.

GENERAL: As the present condition of the pier at Fairport Harbor, Ohio, inside the shore line, is such that the question of its further maintenance by the United States must be decided at an early day, I have the honor to submit the following statement and recommendation:

Under date of June 22, 1889, certain conditions were accepted by H. W. Oliver, president Consumers' Forwarding and Storage Company, Pittsburg, Pa., for use of United States east pier at Fairport Harbor, Ohio, one of the conditions being an annual rental of $2,000 to be paid to the United States by the company. I am unable to find a copy of the license in the records of this office.

Under date of July 15, 1890, the first annual payment was remitted to this office by the company.

Under date of June 18, 1891, a request was made to the company for remittance of the second annual payment of $2,000, which was declined, under the plea that the license was only for one year and that no payment was therefore due. The same was reasserted in subsequent correspondence. The matter was therefore laid before the Chief of Engineers in a letter from this office dated July 16, 1891 (3952 of 1891).

Under date of September 17, 1891, the Attorney-General of the United States informed the Secretary of War that the matter had been referred to the U. S. attorney for the northern district of Ohio for such action as may be necessary. There is no record in this office of any action on the subject by the U. S. attorney.

In the summer of 1891 a beacon for rear light of range was erected on the United States pier, which was so situated as to interfere with the use of the company's iron hoist. The company then practically offered to pay the rental provided the beacon was removed, but no further action was taken.

The pier has been constantly used by the company which obtained the license, though perhaps under some modification of name. The outer tracks of the iron hoists are on the pier, and railroad tracks and piles of ore are close to the inner edge of the pier, which thus becomes a mere wharf front to retain the material behind it. Directly over the pier, and partly resting on it near the shore line, the company built some coal hoists, which are still in position, though at present not in use. The use to which the pier has been subjected has done it very great injury, vastly more than can be repaired by the amount paid to the United States for one year's rental.

In November, 1893, I had a survey of the harbor, made with special reference to the condition and occupancy of the east pier. I inclose a copy of the report of Mr. F. S. Burrowes, the assistant engineer, who made the survey, and a blue print of the map of the harbor.

An examination of the map shows at a glance that the transportation company has taken possession of the entire wharf front of the town, streets included. In fact, it is understood that the small city government is practically controlled by the transportation company. The business of Fairport Harbor is thus far but little save what is done by corporations or companies under a single management.

I am therefore constrained to make this statement of the general features of the situation, and to recommend that, until other circumstances may arise to change the present conditions and necessities, no expense shall be incurred by the United States to keep the east pier in repair inside of the shore line, and that no dredging be done in the channel inside of that line.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

CLEVELAND, OHIO, *February 21, 1894.*

COLONEL: I have the honor to submit the following report upon a partial survey of Fairport Harbor, Ohio, made under your direction in November, 1893:

The primary object of the survey as conveyed in your verbal instructions was to ascertain the general dimensions and conditions of the Government piers, more especially the one on the east side. Incidentally the survey was to include the docks, railroad and ore-hoist tracks, iron-ore piles, and street adjacent to the water front in Fairport. A map of the survey, plotted to a scale of 1 : 2000, and showing the above features, is submitted herewith. The soundings on the map outside the line A-B, are taken from a survey made in June, 1893, by Mr. William T. Blunt, assistant engineer. The soundings on the map inside of the line A-B were taken in April and May, 1891, by W. G. Hawkins, inspector.

Fairport Harbor is at the mouth of Grand River, and its improvement has been of the usual type; that is, nearly parallel piers have been built, one on either side of the mouth of the river and extending out into the lake. The channel width between the piers varies from 184 feet at the outer end to 198 feet near the life-saving station, the general width being about 187 feet. The piers are composed of timber cribs filled with stone. The width of the piers varies from 15 feet to 24 feet and the height from 5 feet to 8 feet above mean lake level.

East pier.—The east pier as a crib construction now ends at what is known as the old range pier and has a total length of 1,760 feet. Inside of the old range pier and extending up the river about 4,000 feet there is a dock built of piles, capped and decked, and used by the Dock Company as a wharf for handling and storing iron ore. Beginning at the outer end, the east pier may be described as follows: For a distance of 524 feet the pier is 24 feet wide and is in good condition; next there is an old light-house crib 30 feet square which appears to be solid and has retained the stone filling. Inside the old light-house pier for a distance of about 600 feet the pier is 18 feet wide. Although this part of the pier has settled badly out of shape, it seems fairly sound and stable and has retained its stone ballast. It could be repaired by replacing the deck stringers and plank and possibly some of the side timbers on the inner end. If thought advisable to entirely replace the superstructure, I think it could be done with safety, as the fact that the stone ballast has remained in place would seem to show that the submerged crib is sound.

For the balance of the distance, 614 feet, the pier is only 15 feet wide and is in a very dilapidated condition. The cribs of which it is built were evidently placed directly upon, or very little below, the natural surface of the bottom of the river. Dredging and scouring action have since partially undermined them, allowing the ballast to run out and causing the cribs to cant toward the river. In one place for a distance of about 150 feet the cribs have been almost entirely overthrown. The repair of this part of the pier would be practically impossible, and the only thing that could be done would be to entirely remove it and replace it with deeper and heavier construction.

About 1,100 feet from the outer end of the pier the Dock Company has constructed a bulkhead of timbers and piles running normal to the pier for about 200 feet, then turning and running parallel to the pier until it intersects the shore line. The area included between the bulkhead and the pier has been filled and tracks and platform laid, so that it can be utilized for handling and storing ore. A coal chute has also been built near the outer end of this area and directly upon the Government pier. The part of the pier inside of this bulkhead would seem to be no longer necessary as a contraction work, but might be useful as an ore dock. This would include all of the 15-foot pier and about 50 feet of the 18-foot pier.

West Pier.—Beginning at the outer end, the west pier for a distance of 483 feet is 24 feet wide and is in good condition, the only repairs necessary being some new decking. For the next 137 feet the pier varies in width from 20.5 to 22 feet. This part of the pier has canted toward the channel, so as to make the inner edge about 2 feet lower than the outer; otherwise it seems to be in fairly good condition and could be repaired without great expense. From here in to the life-saving station, about 620 feet, the pier is 18 feet wide, and, although the superstructure appears to be fairly sound, yet it is old and will soon have to be renewed. The sand has gradually accumulated west of the pier until it is now level with the top of the superstructure to within 825 feet of the outer end. Inside of this point the pier is no longer needed as a contraction work or to prevent the drifting of sand across the channel, and its repair would not appear to be necessary.

Fairport Docks.—A glance at the map will show that practically the whole of the water front of Fairport is used as a wharf for handling and storing iron ore, and is almost completely covered with railroads, ore hoists, tracks, and iron ore in piles 20 to 25 feet high. This business is in the hands of a corporation variously known as the Consumers' Storage and Forwarding Company, Pennsylvania and Lake Erie Dock Company, Fairport Dock Company, and Pittsburg, Fairport and Northwestern Dock Company. It is locally known as the Dock Company, and has been so referred to in this report. These docks form practically the terminal facilities for the Pittsburg, Painesville and Fairport Railroad, now leased by the Pittsburg and Western Railroad, which, I understand, is a part of the Baltimore and Ohio Railroad system.

I was told by a member of the village government that the village council had abandoned the following parts of streets: All cross streets west of Water street; also all cross streets west of High and south of Third, and Water street south of Third. This gives the Dock Company complete control of the water front, leaving no approach to it free, by right, to the public. At the time of the survey there was no ore stored on the line of Third street, but it was obstructed west of Water street by railroad tracks and tracks for ore hoists, so that this area could also be used for storage of ore at any time the Dock Company might think it advisable.

Very respectfully, your obedient servant,

F. S. BURROWES,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers, U. S. A.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., March 20, 1894.

SIR: The river and harbor act of August 11, 1888, in the item making an appropriation for continuing the improvement of Fairport Harbor, Ohio, contains the following provision (25 Stat. L., 405):

"That the owners of dock property abutting on Grand River, at the mouth thereof, shall have the right to load and unload coal, ore, and other freight over so much of the east Government pier as lies north of the present low-water mark, under such limitations as to time and use as shall be approved by the Secretary of War, on the payment of such compensation as the Secretary of War shall determine."

In accordance with this provision of the law, the Secretary of War granted, June 22, 1889, to the Consumers' Forwarding and Storage Company, a corporation organized under the laws of the State of Pennsylvania, a license to enter upon the said pier for the purposes in the act upon certain conditions named in the instrument for the term of one year. One of the conditions of the license was that the company should pay a rental at the rate of $2,000 per annum, payable at the expiration of the year. This rental was paid by the company for the year ending June 22, 1890, but through oversight the license was not renewed, and when demand was made for the rental for the succeeding year, the company refused to pay it, and denied any liability for the amount, on the ground that the license had expired. It was not believed that this contention was tenable, or that failure to renew the license absolved the company from the obligation to pay for the period during which the pier was used. It was thought that the continued use of the pier by the company was practically evidence of a willingness to abide by the terms of the original license, and, in the absence of objection by the United States, would operate as an extension or renewal of the said license.

Accordingly the Secretary of War, under date of August 22, 1891, referred the papers to the Department of Justice, with the request that they be placed in the hands of the proper U. S. district attorney, "with directions to take such action as the nature of the case demands or advise this Department what to do." By letter of September 17, 1891, the Attorney-General advised the Secretary of War that the matter had been referred to the U. S. attorney for the northern district of Ohio "for such action as may be necessary."

It is not known that the U. S. attorney has ever taken any action on the subject. The pier has been constantly used by the company which obtained the license, though perhaps under some modification of name, and no payment has been made for such use since that made for the year ending June 22, 1890.

I have the honor to recommend that the subject be again brought to the attention of the Attorney-General, and that he be requested, if in his opinion the company can be held liable for the rental under the original license, to direct the U. S. attorney to take the necessary steps to collect the said rental, and if in his opinion the company is not so liable, that he direct the U. S. attorney to institute proceedings to restrain the company from using or occupying the pier except under such new limitaand terms as the Secretary of War may prescribe.

A copy of the license is herewith.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

HON. DANIEL S. LAMONT,
Secretary of War.

[Indorsement.]

WAR DEPARTMENT, *March 23, 1894.*

Respectfully transmitted to the honorable Attorney-General, with request that action may be taken as recommended in the within letter of the Chief of Engineers.

DANIEL S. LAMONT,
Secretary of War.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 24, 1894.

COLONEL: Referring to your letter of the 14th ultimo, regarding the occupancy of the United States east pier at Fairport Harbor, Ohio, by the Consumers' Forwarding and Storage Company, I have to invite your attention to the action of the Department, as shown by the accompanying copy of letter of March 20, 1894, from this office to the Secretary of War and by the Secretary's indorsement thereon of March 23.

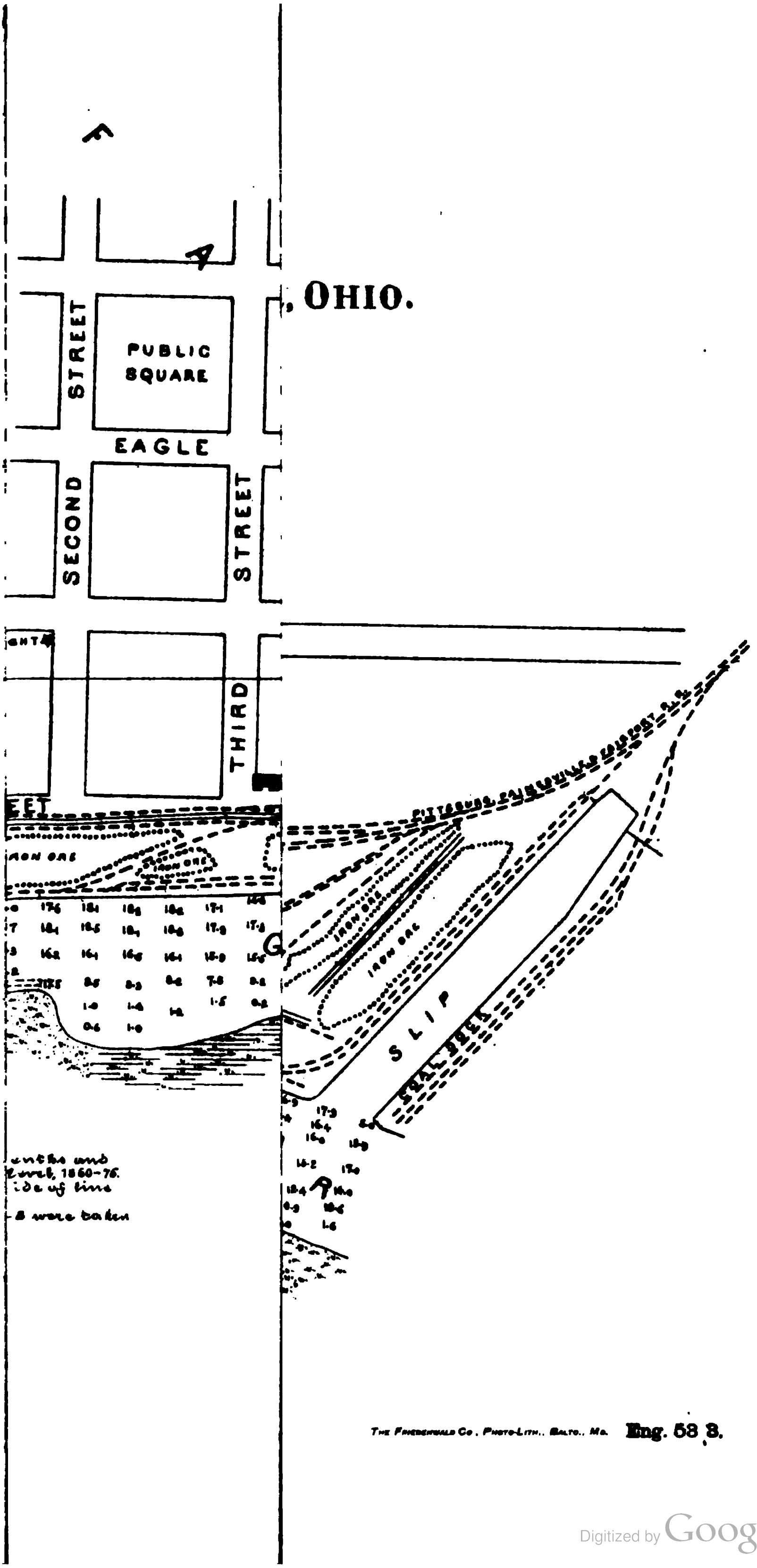
By command of Brig. Gen. Casey:

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Lieut. Col. JARED A. SMITH,
Corps of Enginee

Until the question thus placed before the Department of Justice can be definitely settled, no recommendations will be submitted for expending any sum of money for repairs of the part involved. If the company owning the adjacent land and operating the works which require use



The Friedenwald Co., Photo-Lith., Balto., Md.

Eng. 58 3.

of the Government pier, which has now become the wharf front, would take the pier on a lease which simply requires it to be kept in good condition as the sole consideration for its use, it would perhaps be more satisfactory to the company and would save expense to the United States.

There seems to be no good reason why owners of lands adjacent to a channel should be shut out from the riparian privilege of using the channel to load and unload vessels on their own front, but if such loading and unloading has become possible only through expenditures made by the United States, then the United States might with all modesty claim the right to have its work maintained without further cost to itself.

A reduced copy of the map mentioned in Mr. Burrowes' report is forwarded to accompany and explain this report.

Fairport Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on the shore and a beacon on the east pier

Money statement.

July 1, 1893, balance unexpended	$34, 864. 76
June 30, 1894, amount expended during fiscal year	28, 048. 24
July 1, 1894, balance unexpended	6, 816. 52
Amount (estimated) required for completion of existing project	190, 000. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	100, 000. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Fairport, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Iron ore	792, 517	Coal	237, 889
Grain	22, 982	Merchandise	29, 722
Flour, etc	69, 639	Total	267, 611
Stone	6, 996		
Miscellaneous merchandise	55, 856		
Fish	12		
Total	948, 002		

Total freight tonnage for 1893	1, 215, 618
Total freight tonnage for 1892	1, 103, 197
Increase	112, 416

Shipping.	Number.	Tonnage.
Vessels entering	489	599, 250
Vessels departing	444	528, 360

Total registered tonnage for 1893	1, 127, 610
Total registered tonnage for 1892	1, 515, 511
Decrease	387, 901

Draft of largest vessels using harbor, 16 feet.

Depth of water prevents largest vessels from loading to full depth.

No new vessel lines established during the year.

N N II.

IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

In 1826 the natural conditions of Ashtabula River afforded but 2 feet depth of water over the bar at the mouth, and the rock bottom was but 9 feet below the surface of the lake.

A plan was adopted to improve the channel by confining it between parallel piers of timber work filled with stone. The plans have been modified and extended from time to time as the necessities of commerce required, and have included the removal of material overlying the rock and also of the shaly rock itself to a depth of 17 feet. A large amount has been necessarily expended in repairing the old work, because even the best timber above water becomes almost entirely decayed in fifteen years.

The latest project, proposed in 1890 and amended and approved in 1891, consists in widening the channel by placing the east pier 45 feet farther eastward, and deepening the channel by extending the piers to a depth of 22 feet in the lake and removing the rock to a depth of 20 feet.

At the beginning of the fiscal year work was in progress under contract to remove and rebuild 242 feet of the old east pier, and to extend both the east and west piers. Work had been commenced March 13, 1893; it was continued until December 23, 1893, when it was completed.

During the season a part of the old east pier 242 feet long, standing on the rock bottom in a depth of about 16 feet and having a superstructure 6 feet high, was removed, and a corresponding amount of entirely new work with superstructure 8 feet high, was built to replace it, the new work being parallel to the old and 45 feet further eastward. This makes the width between piers 213 feet.

The east and west piers were then each extended 240 feet, making a total of 722 feet of new pier constructed. A part of the old east pier 116 feet long was removed by the Lake Shore and Michigan Southern Railroad Company that part being a part of the work done by the railroad pursuant to the authority received from Congress.

The new pier constructed is of a very substantial kind. The essential features of the design are shown in plans submitted with annual report for Conneaut Harbor, Ohio, but they were modified as follows:

The section of 242 feet to replace old pier removed was built as far as practicable on same design as the old work. It was left optional with the contractors whether to use the old cribs, after emptying them and putting them in good condition, or to remove them entirely and to build new work in their place. The latter method was chosen, and the old work was torn out and removed by dredging.

Designs for the new work had been in cribs of 40 feet length. The section of 240 feet extension on east side was made in the following manner:

The crib bottoms, 40 feet each in length, were constructed to a height of 4 feet, or four courses of side timbers, which included all vertical screw bolts; the angle timbers were secured in place at the bottom and held by braces; the bottoms were then launched and placed end to end in two sections of 120 feet each; the two cribs of hemlock timber were then built up in solid work, each reaching over three of the bottoms as launched. The top course of each crib is of pine, and its top is about 1 foot below the mean lake level. The sand and small stones were dredged from the top of the rock, and the cribs were sunk to the solid stone. The surface of the ledge of rock under the first crib sunk is somewhat irregular, but not sufficiently so as to cause any injury to the work or unusual difficulty in construction.

On the west side the entire extension of 240 feet was made in a single crib with the bottoms four courses high in lengths of 40 feet each, as before. This method has some disadvantages in construction, mainly due to the difficulty of sinking and filling with stone in a sufficiently short time, but these disadvantages were in this case easily overcome, and the result was very gratifying.

Where cribs are sunk in short lengths, it is exceedingly difficult to get the ends close together, and to preserve an exact alignment and level on top. The leveling and adjusting of lower courses of superstructure are, therefore, often troublesome and expensive.

With very long cribs the number of joining places is reduced, and the superstructure is put on at a minimum of expense. In this instance the method of long cribs was doubtless the means of saving the entire work from destruction. At the time of the great storm of October 14, 1893, the crib was in place and had been filled with stone; a part of the superstructure on the shore end had been constructed, but no portion of it had been covered with decking.

When cribs are thus exposed in a storm the sea dashes over the outer cribs and forces the stone out of the compartments; in extreme cases the crib is so nearly emptied of ballast that it can not withstand the seas, and it is then carried away bodily. At Ashtabula the outer compartments of the long crib on west side were nearly emptied of stone, and had the structure been a succession of short cribs there appears to be little doubt that each would have been emptied in turn and carried away. Owing to the solid construction in a section 240 feet long the outer end was moved but a few inches only, and brought no inconvenience save the loss of stone which was taken from the crib by the sea.

The cost of removing and rebuilding 242 feet of pier was $20,600, or about $85.16 per foot. The cost of extending piers 480 feet with two pier heads was $39,732.22, which is nearly $82.78 per foot.

A part of the project of improvement is the renewal of superstructure of west pier.

In the spring of 1894 there remained a balance of about $13,000, and it was considered advisable to expend the sum in rebuilding superstructure of west pier. The most economical and advantageous method of doing the work was believed to be by hired labor and purchases in open market.

Authority was obtained for the purpose, and work was begun by hired labor April 23, 1894. At the end of the fiscal year a section of superstructure 18 feet wide and 6 feet high had been removed over a length of 293 feet, and a part of same, 248 feet long, had been entirely rebuilt, save planking. It is proposed to continue this work as far as available funds will permit.

On the 18th of May, 1894, the steamer *C. F. Bielman*, in tow of tug *William D.*, of Ashtabula, was entering the harbor, when the steamer's bow was run into the end of east pier, striking it almost exactly in the middle and cutting it down to a depth of 16 feet. The end of the pier was forced apart as if by a wedge, and timbers were broken to such an extent that the cost of repairs is estimated to be $2,000.

The question of responsibility for the injury is disputed between the vessel owners and tug owners, and it may be necessary to have it decided in a court of law. Meantime it will be necessary to make the repairs to prevent further injury, leaving the question of payment for later consideration.

Previous to commencement of work on present project the amount expended for improvements, repairs, and maintenance, from 1826 to 1891, inclusive, was $458,734.46.

A balance of $8,666.75 from the appropriation of September 19, 1890, became applicable to the latest project; also amount appropriated by act of July 13, 1892, $70,000.

Ashtabula is now the greatest shipping point for coal and ore upon Lake Erie.

A map of Ashtabula Harbor is forwarded to accompany and explain this report.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order, varied by flashes on the west pier. Fort Porter, N. Y., is the nearest work ot defense.

Money statement.

July 1, 1893, balance unexpended	$70,053.02
June 30, 1894, amount expended during fiscal year	63,216.07
July 1, 1894, balance unexpended	6,836.95
July 1, 1894, outstanding liabilities	560.50
July 1, 1894, balance available	6,276.45
Amount (estimated) required for completion of existing project	255,000.00
Amount that can be profitably expended in fiscal year ending June, 30, 1896	255,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Ashtabula, Ohio, were compiled from commercial report in newspaper, purporting to emanate from the office of collector of customs for the district.

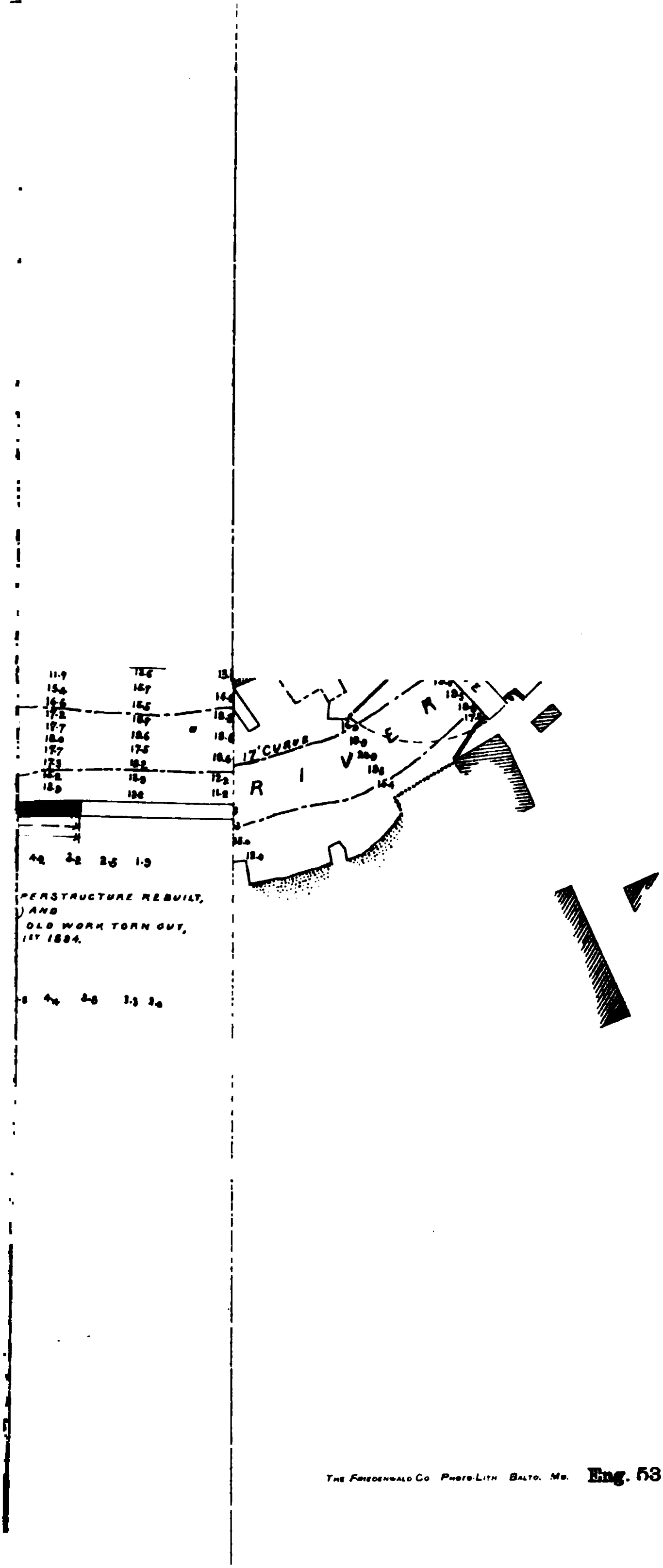
No reply was received to request made to collector of customs for commercial statistics.

Articles.	Tons	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Iron ore	1,856,624	Coal and coke	788,453
Stone	9,806	Total	788,453
Lumber	2,281		
Railroad ties, etc	2,660		
Fish	136		
Total	1,871,507		

Total freight tonnage for 1892	4,231,000
Total freight tonnage for 1893	2,659,960
Decrease	1,571,040

Shipping.	Number.	Tonnage.
Vessels entering	1,154	1,359,482
Vessels departing	1,130	1,306,721

Total registered tonnage for 1893	2,666,203



THE FRIEDENWALD CO PHOTO-LITH BALTO. MD. **Eng. 53 3.**

N N 12.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

Conneaut Harbor is formed by the Conneaut River or Creek near its mouth at junction with Lake Erie. Improvements at this place were commenced under an appropriation made by Congress March 2, 1829, and were continued at irregular intervals until 1875.

The amount appropriated and expended during the period from 1829 to 1875 was $106,629.39.

As a result, the channel, which originally had a depth of only about 2 feet, was increased to a depth of 8 or 9 feet ordinarily and to 11 feet under very favorable conditions.

The river and harbor act approved July 13, 1892, appropriated $40,000 "for relocation of channel and construction of new piers." (Scheme B, of Engineer Report).

The location was modified by an act approved February 24, 1893. (See Annual Report of Chief of Engineers, 1893, pp. 3089, 3090, and map opposite last-named page.)

At the end of the last fiscal year surveys, borings, and other necessary examinations had been made, and a contract had been made with Messrs. L. P. & J. A. Smith, of Cleveland, Ohio, for constructing new pier work in extension of the old west pier.

Advertising for the contract had been unavoidably deferred until after the act of February 24, 1893, which modified location of channel, so that the contract was not finally approved until June 12, 1893.

At such a season of the year it is quite impracticable to cut timber in the woods specially for such a work, and suitable timber is difficult to procure. The work of framing cribs was therefore deferred until July 31, and for several weeks later was carried on very slowly owing to lack of material. The work was continued until the end of November, when it was completed, with the exception of a few planks of the decking, which could not be secured owing to the ice which had covered the pier during the latter part of November.

Early in December the ice thawed away, and the planking was completed December 9. The months of October and November were unusually unfavorable for such work by reason of heavy winds and storms. On the 14th of October a northwesterly storm of great violence traversed the entire length of the lake, doing great injury to shipping and to pier work under construction. The piers on west side at Conneaut rest upon the sand; in order to make them as stable as practicable, and to prevent any future possibility of being undermined when the channel may be deepened by scour of currents in freshets or by dredging, the stone foundations were placed in a trench excavated to a depth of 22 feet below the mean lake level.

In the trench was placed a mass of rough stone 3 feet deep and 8 feet wider than the cribs, projecting 4 feet on each side. To prevent washing away of the stone at the outer edges and consequent settlement, tipping, and change in alignment of piers, the stone of foundation were required to be large with small stone to fill the interstices and make the mass compact.

The cribs were thus at first placed on a foundation 19 feet below water surface, but when filled it was expected that the cribs would settle into the foundation about 1 foot. This estimate of settling is found to be practically correct with the type of cribs which are used. The amount of settlement varies, however, and is largely dependent upon the kind of construction used for the bottom of the cribs.

In the severe storm mentioned the outer cribs at Conneaut, which had been sunk in place on a very excellent alignment, were apparently moved, more or less, to westward, and were left sufficiently out of level to make the tops very irregular and to make the securing of superstructure very difficult. The outer end of outer crib was swung and tipped sufficiently to throw it about 2 feet west of the proper line. One hundred cords of stone were washed out of the cribs, and as the cribs had been accepted under the contract, the stone was replaced at the expense of the United States.

No other damage was caused to the work by the storm, but it was sufficient to call attention to the causes of the displacement and to show the necessity for a method of construction which will prevent a recurrence of the difficulty.

It is evident that in rough weather the force of the water in seas approaching the crib would have no tendency to lower the surface of the sand bottom on the side of approach. The waves would, however, be raised very high at times by the resistance of the pier, and in its fall the reacting force would cause a strong current and tendency to wash away the sand near the crib.

A similar effect would be produced by seas which strike the pier obliquely and which chase along the side, producing very strong currents at the bottom close to the pier. The effect of this action of the sea is to scour a deep channel close to the pier and along the weather side. The stone at edge of foundation slides into this channel and by degrees the support of the crib on that side is lowered so that the crib tips and the top is thrown out of alignment. The vibration of the crib under the violent action of the waves seems to be an element in causing movement of the crib, for it is apparent that at times the crib moves bodily toward the direction from which the storm arrives.

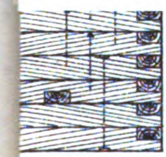
The crib construction employed thus far at Conneaut was of a very substantial type, devised by me specially for use at Conneaut and Ashtabula, Ohio; drawings of the crib are shown on a sheet accompanying this report. On a second sheet are drawings of a crib designed to check the scour at the base sufficiently to prevent the unequal settlement and change of alignment.

It is proposed to try this method of construction in the next pier work at Conneaut, or other place having a sand bottom. The expense does not differ materially from the other type of foundation, and it can hardly fail to serve a good purpose even if it does not accomplish all that is hoped for it.

The iron shown in the bolting of cribs is round-rolled iron, 1⅛ inches in diameter; the bolts are slightly upset and swaged to form a head, and the point is merely a small bevel at the outer edge so that in driving it will not tear away the fiber of the wood. A drawing of the bolt is shown on sheets with crib designs.

The cribs of west pier extension are 24 feet wide and the superstructure is raised eight courses of timber, a trifle more than 8 feet above the water level. The entire length of new work completed is 400 feet. For this the amount paid the contractor was $38,083.93, which includes 100 cords of stone in addition to amount required to fill the cribs, that amount having been carried out in the storm.

The estimated cost of the entire work is	$500, 000. 00
Amount appropriated July 30, 1892	40, 000. 00
Amount expended to June 30, 1893	692. 91
Amount expended during last fiscal year	39, 286. 15
Total expended to June 30, 1894	379, 979. 06



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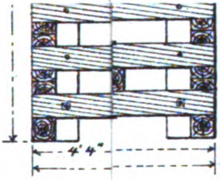

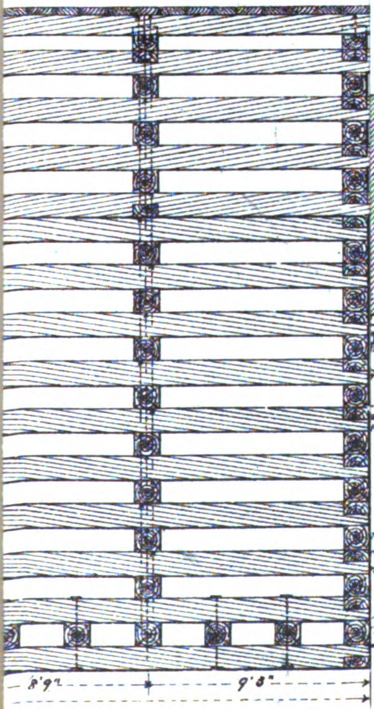

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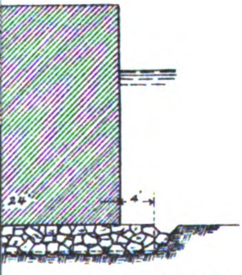

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Engineers, U. S. Army.

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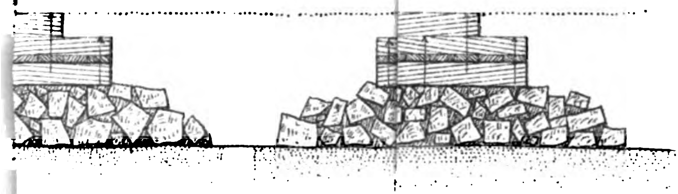

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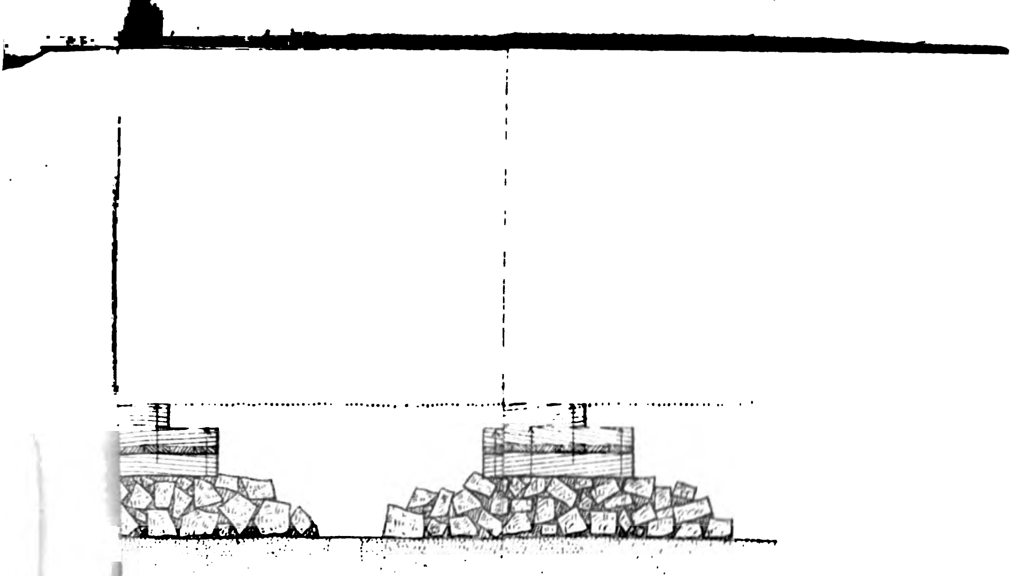

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The old west pier is not on the same line as the new work, so that its outer end is exposed on the west side. The heavy seas and storms of October and November tore away the superstructure on outer end of old pier, and it was temporarily repaired.

The railroad company also went to considerable expense to secure the old pier, because if it were to break through the channel would be ruined.

The Pittsburg, Shenango and Lake Erie Railroad Company has dredged the channel to a depth of 17 feet or more, and, although shipments were only commenced late in the season of 1893, a large amount of coal and ore were shipped, as will be seen by reference to commercial statistics appended hereto.

The company has now in operation: 6 Brown hoists, 2 King Bridge hoists, 4 Excelsior hoists, and 2 McMyler hoists.

Two thousand feet of wharf front has been practically completed and covered for coal and ore, a width of 330 feet.

As soon as further funds are available it is proposed to strengthen the outer end of old west pier, and then to commence the construction of east pier from the shore line into the lake as far as funds will permit.

Conneaut Harbor is at the mouth of Conneaut River, 13 miles east of Ashtabula, and is near the boundary between the States of Ohio and Pennsylvania. It is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the sixth order upon the bank near the mouth of the river, and a small beacon on the outer end of west pier.

Money statement.

July 1, 1893, balance unexpended	$39,307.09
June 30, 1894, amount expended during fiscal year	39,286.15
July 1, 1894, balance unexpended	20.94
Amount (estimated) required for completion of existing project	460,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following statistics for the year 1893, relative to the commerce of the harbor at Conneaut, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Iron ore	201,587	Coal	23,815
Lumber	25,637	Flour	74
Stone	13,107	Lumber	115
Staves	200		
Flour	19	Total	24,004
Total	240,550		

Total freight tonnage for 1893	264,554
Total freight tonnage for 1892	1,625
Increase	262,929

Shipping.	Number.	Tonnage.
Vessels entering	150	150,470
Vessels departing	151	150,476
Total registered tonnage for 1893		300,946

Draft of largest vessels using harbor, 17 feet.

Largest vessels load to full depth.

No new vessel lines established during the year.

The following statement has been received from the agent of the Pittsburgh, Shenango and Lake Erie Railroad Company, at Conneaut, giving the arrivals and departures of vessels, and their freights, from opening of navigation to June 30, 1894:

Month.	Vessels.	Coal.	Vessels.	Ore.
		Tons.		*Gross tons.*
April	4	975		
May	2	135	14	28,750
June	7	1,300	28	49,460
Total	13	2,410	42	78,210

The above, in tons of 2,000 pounds, would be: Coal, 2,410 tons; ore, 87.595 tons; total, 90,005 tons.

N N 13.

REMOVING SUNKEN VESSELS OR CRAFT OBSTRUCTING OR ENDANGERING NAVIGATION.

On the 9th of May, 1893, the three-masted schooner *Pelican* foundered in Lake Erie opposite the entrance to Ashtabula Harbor and at a distance of about 1 mile from the light-house on end of the piers. The masts projected to a considerable height above water and the hull, loaded with iron ore, was directly in the way of passing vessels.

An allotment of $50 was made for an examination of the sunken vessel, and subsequently the sum of $2,500 was allotted for its removal.

Advertisements inviting proposals for removal of the wreck to a depth of 33 feet below mean lake level were issued August 28, 1893. Proposals were opened September 15, 1893, and the contract was awarded to Mr. John Stang, who was the lowest bidder, the price being $1,200.

The wreck was to have been completely removed on or before November 30, 1893. The work was, however, delayed by various causes, and on an application of the contractor the time for completion was extended to April 15, 1894. The removal of the wreck was completed January 9, 1894.

The total amount expended during the year upon the removal of wrecks was $1,490.68.

Abstract of proposals for removing wreck of schooner Pelican, near Ashtabula Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, September 15, 1893, at 2 o'clock p. m., standard time, in accordance with advertisement dated August 28, 1893.

[Net amount available, $2,509.80.]

No.	Name and address of bidder.	Amount.
1	John Stang, Lorain, Ohio	$1,200
2	Walter V. Metcalf, Cleveland, Ohio	1,540
3	Thos. E. Wilson, Cleveland, Ohio	4,000

Recommended that the contract be awarded to Mr. John Stang, his bid being the lowest, and he responsible.

APPENDIX O O.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA, AND OF RIVERS AND HARBORS IN WESTERN NEW YORK.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Erie Harbor, Pennsylvania.
2. Presque Isle Peninsula, Erie Harbor, Pennsylvania.
3. Dunkirk Harbor, New York.
4. Buffalo Harbor, New York.
5. Tonawanda Harbor and Niagara River, New York.
6. Niagara River from Tonawanda to Port Day, New York.
7. Wilson Harbor, New York.
8. Olcott Harbor, New York.
9. Oak Orchard Harbor, New York.

HARBOR LINES.

10. Squaw Island, Niagara River, New York.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 6, 1894.

GENERAL: There are forwarded herewith the annual reports for the year ending June 30, 1894, for the works under my charge: The harbors of Erie, Pa., Dunkirk, Buffalo, Wilson, Olcott, and Oak Orchard, N. Y., and for Tonawanda Harbor and Niagara River, New York, and for Niagara River from Tonawanda to Port Day, New York.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

O O 1.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

Object.—The object of this improvement is twofold:

1. To protect the harbor from severe winds from the east and northeast.

2. To obtain and maintain a channel, between deep water in the harbor and the open lake, 16 feet at low water and of navigable width.

Project.—The project, as originally prepared in 1823 and approved in 1824 (at which time the entrance to the bay was narrow and tortuous and only 6 feet in depth) provided for closing all of the eastern end of the harbor by means of a breakwater, in which should be left an opening 200 feet wide, and for extending to deep water in the lake two parallel piers, one on each side of the opening. This project is substantially in force at the present time, excepting that the piers are 350 feet apart.

Present works.—The present works consist of (1) a breakwater lying north and south from the main shore to the south side of the entrance to the harbor; (2) a pier on the south side of the entrance channel, nearly east and west in position; (3) a pier on the north side of the channel parallel with and 350 feet distant from the pier before mentioned, and (4) a catch-sand jetty, built in 1883, about 3,000 feet north of the north pier, for the purpose of arresting the movement of sand into the channel.

The construction of this jetty is such that it does not serve the purpose for which it was built, and it has received no repairs since its construction. These works are known as (1) the south breakwater, (2) the south pier, (3) the north pier, and (4) the catch-sand jetty.

The piers and breakwater consist of timber crib work, filled with stone and covered with pine-plank deck.

The catch-sand jetty consists of a single row of piles driven close together and bound together with oak walings.

OPERATIONS DURING THE FISCAL YEAR.

Repairs to piers and breakwater.—On the north pier 30 linear feet of decayed fender were removed, at the buoy house, and loose spikes driven down throughout the length of the pier; on the south pier 100 linear feet of deck at west end were patched; on the south breakwater deck-stringers and plank were renewed where gone throughout the length of the breakwater, and the north end, at junction with the south pier, was refilled with stone picked up in shallow water alongside. These repairs were begun on September 25 and completed on September 30, 1893.

The cost of repairs was as follows:

Timber and spikes	$54.30
Labor	64.06
Total	118.36

On October 12, 1893, the *Joseph Paige*, entering harbor, in tow of the steamer *Wocokon*, struck the outer end of the north pier and tore off two fenders. The damage was repaired on October 24, at a cost of $5.90 for material and labor.

A severe storm on October 14 and 15, 1893, caused slight damage to the deck of the south breakwater. The damage was repaired on October 24 at the following cost:

Timber and spikes	$4.06
Labor	3.37
Total	7.43

Extension of the north pier.—At the beginning of the year an extension of 300 feet, eastward into Lake Erie, was well under way. The contractor, J. B. Donnelly, Buffalo, N. Y., completed the extension on August 11, 1893, at a total cost of $25,404.78. The total length of the extension was 301.4 linear feet, making the cost per linear foot of completed pier $84.28.

Surveys.—A survey of the eastern end of the peninsular and harbor entrance, to determine changes in the shore lines and contours offshore, to a depth of 20 feet, was made on October 10 to 12, 1893.

A map of the survey was completed and submitted on December 20, 1893.

Examinations of the channels were made frequently and the water gauge tested and maintained in good order.

Surveillance of the peninsula.—The watchman was on duty during the entire year. He enforced the rules in regard to the building of fires and cutting of trees, or any growth on the peninsula, so far as possible over so large an area (about 4 square miles). No depredations were committed. Small fires, made by hunters, were numerous during November, but all were promptly extinguished by the watchman, aided by members of the life-saving crew, before any damage was done. During November one or more fires (bonfires) were put out almost daily. In addition to his duties on the peninsula, the watchman maintained a careful watch over the dumping of dredgings, and required all dumping to be done in the lake, 1 mile out; cared for the public property in storage; made all repairs and cared for the launch; and acted as engineer of the launch during the season of navigation.

Moving and repairing boathouse.—Owing to improvements and extensions made by the Anchor Line Company, the removal of the boathouse, located on the company's property, became necessary in March, 1894. Permission was therefore obtained from the city of Erie, through the city councils, to occupy the north end of the Peach street slip with the boathouse. The moving of the boathouse was begun on March 26 and completed, together with the thorough repair and painting, on April 17, 1894. The cost was as follows:

Timber, spikes, and paint	$27.23
Labor	106.60
Total	133.83

Dredging in channels.—At the opening of navigation in April, 1894, during a very low stage of water and prevalent northeast winds, shoaling occurred along the north half of the outer channel, outward from the north pier. The depth in this portion of the channel was reduced by shoaling to 16 feet at low water over an area about 200 feet square.

A vessel entering the harbor before the channel stakes were set ran aground on the shoal, and in working off raised a hummock about 150 feet east of the pier and nearly in midchannel. The depth of water on this hummock, about 40 feet in diameter, was only 15 feet at low water and 16½ feet at mean lake level. Its removal being important and necessary, arrangements were made with the only dredge available at the port to do the necessary dredging at the rate of $9 per hour. The dredge, however, could not do the work until released from a contract on which it was employed.

The shoal was therefore marked by buoys early in May and the buoys maintained until June 1, when, the lake level having reached mean stage, buoys were no longer necessary. At the close of the year the dredge was not yet available for the dredging.

CONDITION OF THE WORKS.

South breakwater.—This structure is old and much decayed. Its total length is 2,024 feet; height above mean lake level, 1½ feet; width, 6 to 12 feet. At the close of the year the structure was intact but requires minor repairs after every severe storm.

South pier.—Length of this pier is 1,220 feet. The pier is in a fair condition, but the timbers of the superstructure are becoming soft and show decay. Along the portion of the pier not decked over, 650 feet in length, some of the stone filling has been washed out. This portion of the pier will soon require new superstructure for a length of 650 feet and a height of 3 feet, refilling with stone, and the addition of a deck to protect the stone filling.

North pier.—This pier is 2,737 feet long. The westerly 993 feet is old but intact, the timber work being too old and too soft to admit of more than patchwork to the deck. With the exception of 30 feet at the west end of the pier, over which new superstructure was placed by the Light-House Department in December, 1893, to secure Erie Range Beacon No. 1, new superstructure will be needed over this older portion of the pier, 963 feet long, in the near future. The remainder of the pier is in good condition and needs no repairs at present.

Catch-sand jetty.—About 450 feet of the jetty remain. It has been abandoned and is not considered worth repairing.

The channel.—Shoaling is gradually taking place about the harbor entrance. The total length of the channel from the 18-foot contour in the lake at low water to the same contour in the harbor is now about 7,150 feet, made up as follows:

	Feet.
From 18-foot contour in the lake to the east or outer end of the north pier, outer channel	1,000
Between piers	2,750
From west or inner end of piers to 18-foot contour in harbor, inner channel	3,400

The width of the channel when completely clear is 300 feet. A length of channel of 2,000 feet, lying between the piers, is kept thoroughly scoured out by the strong currents which run in and out and thus maintain it in good condition at all times. The outer and inner channels require repeated dredging in order to maintain them at the required depth. At the close of the year the entire channel was in good condition, the depth of water being 18 to 20 feet at mean lake level, or not less than 16½ feet at low water, for a channel width of not less than 275 feet.

PROPOSED OPERATIONS.

Repairs to piers and breakwater.—Minor repairs on all structures will be made as damage occurs from time to time.

No repairs are advisable on the north and south piers at present. The old portions of both structures have been patched, and further patching is not now advisable. The entire renewal of the superstructure of the westerly 963 feet of the north pier and of 650 feet of the south pier will be necessary in the near future. The cost of rebuilding the superstructures is estimated as follows:

For the north pier, 963 feet	$20,000
For the south pier, 650 feet	13,000

Dredging.—Sand bars are liable to form suddenly across the harbor entrance during northeast storms. When necessary, dredging to clear the channel will be promptly done.

REMARKS.

The bar formation above the north pier continues to grow and encroach upon the pier and channel. While this encroachment has not been so rapid during the past year as in previous years, it nevertheless continues to such an extent that further extensions of the north pier, from time to time, seem inevitable. At the beginning of the year, the shore line of the bar joined the pier at station 13 + 30, 1,183 feet from the end of the pier. At the close of the year, the shore line of the bar joined the pier at station 13 + 50, 1,163 feet from the end of the pier. The advance of the shore line was therefore 20 feet during the year. During the year previous the advance was 120 feet.

A comparison of the surveys of 1891 and 1893 shows but little change in the bar shore lines, excepting the advance lakeward immediately above the pier, as stated above, and the recession due to erosion at the point, at the old catch-sand jetty. This recession is shown by the surveys to have been about 160 feet in two years. No change of note in the off-shore depths has taken place.

As yet the only evidence of another bar formation, off shore from the present shore line, is the slight advance lakeward of the contour of the 5-foot depth and the formation of shoals between this contour and the shore line. This formation will, no doubt, continue more or less rapidly from year to year. The source of supply of material added to the bar continues to be the extreme easterly point of the peninsula. As the shore line of the bar advances lakeward, however, and the recession of the point in an opposite direction tends to form a straight shore line from point to pier, the erosion at the point gradually decreases and probably, in time, will cease.

The situation at present, however, reaffirms the opinion advanced in the last annual report that provision should be made for a further extension of the north pier. An extension of 300 feet would furnish protection to the channel entrance for several years. Since the bar formation began to threaten the channel, in 1875, the pier has been extended three times, viz, in 1880, 242 linear feet; in 1891, 452.15 linear feet, and in 1893, 301.4 linear feet. The pier work in all of the extensions is 24 feet wide and 24 feet high, the superstructure being 8 feet high above water.

The outer end of the pier has now reached a point where exposure to greater wave force demands greater stability than that afforded by the section heretofore used. The width of the pier structure should be increased to 30 feet. The cost of an extension of 300 feet, 30 feet wide, at $100 per linear feet, would be $30,000.

The existing project provides for the further extension of the south pier. To complete the project would require an extension of 1,000 feet, at a cost of $65,000. This extension is not considered advisable or necessary under existing conditions. Proposed operations may be confined, therefore, to repairs to piers and breakwater, dredging in channels, and the construction of further pier extension.

The amounts needed for repairs and dredging can not be definitely stated, as damages by storms are liable to occur at any time. Provision should, however, be made for emergencies. I would therefore estimate the needed expenditures as follows:

Pier extension	$30,000
Rebuilding superstructures	33,000
Repairs to piers and breakwater	5,000
Dredging in channels	5,000
Total	73,000

Statement of appropriations and allotments made for improving harbor at Erie, Pa., from 1823 to the present time.

May 26, 1824	$20,000.00	June 23, 1874	$20,000.00
March 25, 1826	7,000.00	March 3, 1875	80,000.00
March 2, 1827	2,000.00	August 14, 1876	40,000.00
May 19, 1828	6,223.18	June 18, 1878	25,000.00
March 3, 1829	7,390.25	March 3, 1879	25,000.00
March 2, 1831	1,700.00	June 14, 1880	25,000.00
July 3, 1832	4,500.00	March 3, 1881	20,000.00
March 2, 1833	6,000.00	August 2, 1882	20,000.00
June 28, 1834	*23,045.00	July 5, 1884	50,000.00
March 3, 1835	5,000.00	August 5, 1886	37,500.00
July 2, 1836	*15,122.80	August 11, 1888	23,000.00
March 3, 1837	15,000.00	September 19, 1890	40,000.00
July 7, 1838	30,000.00	July 13, 1892	40,000.00
June 11, 1844	40,000.00	1823 allotment	150.00
August 30, 1852	30,000.00	1864 allotment	15,000.00
June 23, 1866	36,961.00	1868 allotment	40,000.00
March 2, 1867	25,000.00	1869 allotment	22,275.00
June 11, 1870	20,000.00	1871 allotment	10,000.00
March 3, 1871	29,000.00		
June 10, 1872	15,000.00	Total	871,867.23

Money statement.

July 1, 1893, balance unexpended (including $20,000 reserved for Presque Isle)	$73,082.32
June 30, 1894, amount expended during fiscal year	27,717.47
July 1, 1894, balance unexpended	45,364.85
July 1, 1894, outstanding liabilities	230.00
July 1, 1894, balance available	45,134.85
Amount that can be profitably expended in fiscal year ending June 30, 1896	25,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1893.

Vessels.	Arrivals from—				Departures to—			
	Home ports.*		Foreign ports.		Home ports.*		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steam	579	732,668	96	23,223	594	745,692	75	6,628
Sail	140	90,756	24	3,845	152	97,396	17	1,334
Total	719	823,424	120	27,068	746	843,088	92	7,962

* Through vessels touching at the port not included.

Greatest draft of vessels, 16½ feet.
Decrease of tonnage, 1893 under 1892, 708,403 tons.
Amount of revenue collected, fiscal year ending June 30, 1893, $3,510.65.
Value of foreign exports, $8,073.
Value of foreign imports, $32,864.
Enrolled tonnage, port of Erie, 1893, 37,620 tons.
Enrolled tonnage, port of Erie, 1894, 36,055 tons.
Decrease in tonnage, 1894, 1,565 tons.

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* Two appropriations.

IMPORTS BY LAKE.

[Tons of 2,000 pounds.]

Articles.	Year ending December 31—						
	1887.	1888.	1889.	1890.	1891.	1892.	1893.
Merchandise	13, 488	15, 782	36, 657	42, 857	21, 611	37, 491	68, 374
Limestone			6, 000	24, 414	14, 343	5, 626	12, 991
Stone			17, 640		4, 668		
Plaster			2, 433	9, 295	15, 169	1, 784	21, 294
Laths	338	460	540		352	343	135
Shingles		100		110		20	
Produce				5	3	12	
Stave bolts				2, 488	1, 500	863	
Ice				4, 700			
Copper and lead				8, 523		704	7, 954
Phosphate				500			
Barley	1, 970	2, 383	2, 138	2, 644	1, 923	1, 900	1, 825
Corn	10, 000	46, 083	98, 230	200, 721	58, 720	147, 256	210, 770
Oats		1, 090	8, 823	80	2, 905		5, 743
Wheat	45, 062	9, 530	83, 815	45, 354	206, 152	237, 630	101, 051
Rye			2, 815	6, 888	17, 440	10, 915	6, 232
Flaxseed	3, 104	2, 836	250	1, 500	14, 090	7, 866	6, 877
Flour	91, 935	96, 935	152, 225	143, 428	97, 198	200, 190	170, 438
Lumber	6, 900	16, 809	22, 500	20, 379	14, 249	21, 567	12, 843
Pig iron	8, 521	12, 477	2, 464	11, 507	5, 175	4, 432	
Iron ore	235, 658	269, 250	417, 270	554, 403	441, 669	720, 504	549, 205
Total	416, 976	473, 735	804, 800	1, 033, 796	917, 757	1, 399, 103	1, 180, 732

EXPORTS BY LAKE.

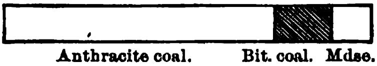
[Tons of 2,000 pounds.]

Coal:							
Anthracite	157, 083	279, 400	258, 534	332, 666	470, 716	428, 735	338, 973
Bituminous	73, 762	125, 848	151, 869	234, 266	176, 704	133, 675	78, 387
Pig and manufacturing iron	397	1, 262		4, 017		400	
Merchandise	93, 228	119, 206	88, 600	127, 074	109, 030	110, 592	45, 918
Tar and oil				1	2		
Stone				1, 836		550	
Timber				400			
Total	324, 470	525, 716	499, 003	700, 260	756, 452	673, 952	513, 278

Erie Harbor, Pa., imports, 1893.

[One inch equals 200,000 tons.]

Exports, 1893.



O O 2.

PRESERVATION AND PROTECTION OF PRESQUE ISLE PENINSULA, ERIE HARBOR, PENNSYLVANIA.

This peninsula forms the harbor of Erie, which is a landlocked bay about 5 miles long, having a maximum width of 1½ miles. The peninsula is a low, sand formation about 6 miles long, varying in width from

300 feet at the "neck," which is nearly 2 miles long and joins the body of the peninsula to the mainland at its western end, to 1½ miles at its widest part. The preservation of the peninsula is of vital importance to Erie Harbor, and it is for the purpose of preserving the harbor that the protection of the weak parts of the peninsula formation has been deemed necessary. The weak portion is the long, narrow neck at the western end. The object for which all the works of protection have been constructed is the prevention of a breach through this narrow neck. The danger exists during severe storms from the westward.

At the present time no works exist excepting a few dilapidated pile jetties no longer of service, and the main line of piles, mattresses, and stone ballast on mattresses, of the shore protection partially constructed in 1889.

A severe westerly storm on August 28, 1893, caused seas to wash over the neck from the lake into the bay. Gullies from 2 to 10 feet wide and 1 to 2 feet deep were cut through the sand on the crest of the neck formation and a few small trees and bushes uprooted. The gullies were, however, soon filled up by drifting sand and the neck practically restored to its normal condition.

The accumulation of sand at the south, or inshore, end of the protection work continues to increase, but no accretion is noticeable along other parts of the work.

Along the lake front, extending a mile or more west from the flash-light house, the gradual wearing away of the bank continued, but as the peninsular is here one-half mile or more wide, the safety of the harbor is not threatened at this point. There was no work done on any of the protection works during the year. A report of the Board of Engineers on the construction of shore protection for the peninsula at Erie Harbor, Pennsylvania, was published in the Annual Report of the Chief of Engineers for 1890, p. 2800. In accordance with the recommendation of the Board and the approval of the Chief of Engineers, no expenditures will be made at present to protect the "neck" of the peninsula on its lake side, and $20,000 of the funds available for the improvement of Erie Harbor are reserved to close any breach which may occur in the neck of the peninsula.

Commercial Statistics—The commercial statistics are the same as those submitted for Erie Harbor.

O O 3.

IMPROVEMENT OF DUNKIRK HARBOR, NEW YORK.

Object.—The object of this improvement is to form an artificial harbor in the indentation of the shore line of Lake Erie, in front of the city of Dunkirk, N. Y.

Project.—The original project was adopted in 1827, and with its subsequent modifications provided for the construction of a pier running out from the west shore of the indentation, and a detached breakwater parallel with the pier and about 2,000 feet distant from the city front. An opening between the two structures provided a harbor entrance through which a channel leading to the docks was to be deepened to 13 feet. By 1832, the sum of $28,439.84 had been expended on the original plan, and a breakwater was then 2,564 feet long and the pier 1,400 feet long. Subsequently various improvements and repairs were made. In 1848 the breakwater was demolished.

In 1870 the question of the improvement of this harbor was referred to a board of engineers. The board recommended a plan which provided for a detached breakwater 2,860 feet long, one part of which, 2,300 feet long, was to be nearly parallel with the shore, the other part to be nearly parallel with the axis of the channel entrance, 560 feet long and terminating at the position of the dumb beacon.

This breakwater and the pier already built were to form the harbor, and the old channel was to be enlarged to 170 feet wide and 13 feet deep. This project is in force at the present time.

Present works.—The present works consist of an unfinished detached breakwater 1,591 feet in length, a part of the 2,300-foot section provided by the project; a pier 1,410 feet long, exclusive of light-house crib, and a channel 100 feet wide and 13 feet deep. The breakwater and pier consist of timber work, the cribs being filled with stone and decked over.

OPERATIONS DURING THE FISCAL YEAR.

At the beginning of the year a contract was in force with Henry K. Gustin, Ann Arbor, Mich., for the construction of an extension of 250 feet eastward to the breakwater. Work under this contract should have been begun in May, 1893, but at the close of the fiscal year 1893, the contractor had not begun work. He was notified that work under his contract must be begun by August 1, 1893, but displayed no intention of carrying out his contract. Therefore, under authority granted, his contract was annulled and a contract was entered into with J. B. Donnelly, Buffalo, N. Y., for the construction of the proposed extension of 250 feet. Work under this contract was begun on August 5, 1893, and the extension fully completed on November 2, 1893.

The total length of the extension is 250.2 feet. The total cost was $14,749.65; cost per linear foot of completed breakwater $58.95.

With the exception of overhauling and tightening bolts in the harbor wall over a length of 200 feet in October, 1893, no repairs were made on the breakwater during the year.

No repairs were made on the west pier during the year. At the close of the year the structure was intact, and only minor repairs, to replace 124 linear feet of waling forced off by ice, considered advisable this season.

After the completion of the breakwater extension it was deemed advisable to dredge the entrance channel to the extent permissible with the funds available. Advertisement was made and proposals opened for the proposed dredging on March 7, 1894, and only one bid was received; but, being reasonable, a contract was entered into with the bidders, Hingston & Woods, Buffalo, N. Y., on March 16, 1894.

Dredging under this contract was begun on May 2, 1894, and continued until June 30, 1894.

The work accomplished was the dredging of a channel 240 feet wide and 13 feet deep at mean lake level across the outer bar; the dredging of the inner channel from deep water at the breakwater to the city docks, 120 feet wide and 13 feet deep, and the dredging of a basin along the dock front 800 feet long, 100 feet wide, and 13 feet deep.

The following table shows the results accomplished and the cost:

Material dredged:		
Outer bar, sand	cubic yards	1,889
Inner channel, mud	do	12,998
Basin, dock front, mud	do	7,860
Total	do	22,747

Total hours dredging	461.21
Total hours towing dredging plant	70
Average number of cubic yards dredged per hour, actual dredging	49.3
Total cost of dredging, including towing	$4,780.89
Average cost per cubic yard dredged ......cents..	21.02

There were removed from the inner channel and basin, along with the mud, 4 large pieces of rock, 6 propeller blades, 1 large anchor, and about 20 pieces of wreckage and logs.

Breakwater.—The breakwater is in fair condition. The structure is intact throughout, and the timber work sound enough to endure for some years, with the exception of the slope, which is much decayed in many places and will require repairs annually.

West pier.—The westerly 420 feet are buried in the sand and need no longer be kept in repair. The next following 434 linear feet of pier are much decayed, but will probably endure for a time, being in shoal water. The next following 110 feet are new. The next following 180 feet are intact, but much decayed and will require renewal in the near future. The remainder of the pier, 266 feet, is nearly new and in good condition.

The channel.—The channel to be maintained is about 2,800 feet long, 170 feet wide, and 13 feet deep, extending from the 14-foot curve in the lake to the city docks.

At the close of the year the entire channel way had just been dredged to the required depth of 13 feet at mean lake level for a width of channel of 120 feet, and a basin 100 feet wide dredged along the entire city dock front 800 feet in length.

The channel was entirely clear for the width noted, 120 feet, excepting that at buoy No. 4, in the inner channel, about 20 feet inside of the westerly channel line, there is an outcrop of solid rock about 12 feet in length, over which the depth of water is 12½ feet at mean lake level. The bottom of the harbor is mud overlying bed rock. The mud flows readily and soon fills the channel way, reducing the depth of water to 10 to 11 feet.

PROPOSED OPERATIONS.

Breakwater.—If not damaged by storms only minor annual repairs will be needed on the breakwater for the next two years.

Pier.—The section of old superstructure on the pier, lying between the new work constructed in 1889, 1891, and 1893, 180 linear feet, should be rebuilt. With this section rebuilt the more important half of the pier would be virtually new work. The reconstruction of the less important or inshore half can be postponed for a time, but repairs will be needed annually.

The channel.—The channel dredging just completed affords a clear channel way 13 feet deep and 120 feet wide from the lake to the city docks, and a basin 100 feet wide and 13 feet deep along the entire dock front of 800 feet. Although the channel is not stable, it should remain adequate for the commerce of the port without redredging for at least two years. An increase in the width of the channel from 120 feet to 170 feet (50 feet) is still required to complete it, as provided by the existing project.

The cost of the needed repairs in existing structures is estimated as follows:

Repairs to breakwater and pier	$2,500
Rebuilding 180 linear feet of pier superstructure	7,200
Total	9,700

The work to be done to complete the existing project is estimated as follows:

Completing channel:	
Dredging 7,000 cubic yards sand, at 40 cents	$2,800
Blasting and dredging 4,000 cubic yards rock, at $2	8,000
Construction of breakwater arm, 560 linear feet, at $70	39,200
Day beacon	5,000
Construction of 709 linear feet of breakwater, at $70	49,630
Total	104,630

Statement of appropriations and allotments made for improving harbor at Dunkirk, N. Y., from March 2, 1827, to the present time:

March 27, 1827	$3,000.00
May 19, 1828	6,000.00
March 3, 1829	9,812.75
April 23, 1830	1,342.75
March 2, 1831	[*]7,102.50
July 3, 1832	10,200.00
June 28, 1834	4,000.00
March 3, 1835	[†]10,988.43
July 2, 1836	11,000.00
March 3, 1837	15,000.00
July 7, 1838	10,000.00
June 11, 1844	5,000.00
August 30, 1852	30,000.00
March 2, 1867	100,000.00
July 11, 1870	25,000.00
March 3, 1871	$25,000.00
June 10, 1872	25,000.00
March 3, 1873	48,132.95
June 23, 1874	35,000.00
March 3, 1875	35,000.00
August 14, 1876	18,000.00
June 14, 1880	10,000.00
July 5, 1884	10,000.00
August 5, 1886	20,000.00
August 11, 1888	15,000.00
September 19, 1890	20,000.00
July 13, 1892	20,000.00
1869	[†]2,000.00
1879	[†]2,000.00
Total	534,079.38

Money statement.

July 1, 1893, balance unexpended	$23,717.40
June 30, 1894, amount expended during fiscal year	19,095.99
July 1, 1894, balance unexpended	4,621.41
July 1, 1894, outstanding liabilities	3,198.92
July 1, 1894, balance available	1,422.49
Amount (estimated) required for completion of existing project	104,630.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	104,630.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

ABSTRACT OF CONTRACTS.

Name.—James B. Donnelly; date, August 3, 1893.

Purpose and consideration.—To build complete 250 linear feet, more or less, of the extension to the breakwater at Dunkirk Harbor, New York, as required by the specifications. That the said James B. Donnelly will furnish and deliver the following materials, and do the work of building the proposed extension, viz:

Hemlock timber, 129,636 feet, B. M., more or less; white pine timber, 175,992 feet, B. M., more or less; foundation stone, 140 cubic yards, more or less; filling stone, 2,530 cubic yards, more or less; screw bolts, 3,651 pounds, more or less; driftbolts, 34,251 pounds, more or less; spikes, 1,350 pounds, more or less; dredging, 200 cubic yards, in scows, more or less.

That the said Maj. E. H. Ruffner shall pay for the said materials and work, after acceptance, as follows: For hemlock timber, $21 per 1,000 feet, B. M.; for white pine timber, $32 per 1,000 feet, B. M.; for foundation stone, $1.75 per cubic yard; for filling stone, $1.75 per cubic yard; for driftbolts, 3¼ cents per pound; for screw bolts (complete) 5 cents per pound; for boat spikes, 4 cents per pound; for dredging, $10 per hour actual dredging and for towing fleet to and from Dunkirk, N. Y.

Name.—Hingston & Woods; date, March 16, 1894.

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[*] Two appropriations.

[†] Allotment.

Purpose and consideration.—That the said Hingston & Woods shall furnish all the plant and do all the work of removing material in Dunkirk Harbor, New York, as required by the specifications.

And the said Maj. E. H. Ruffner shall pay for said plant $9 per hour of actual work of dredging, allowing seventy hours for dredging fleet to come and go, the contractor not to be paid for time lost for repairs or by storms.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels, 1893 (compiled by the collector of customs, Dunkirk, N. Y.).

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steam	39	5,085	2	35	38	5,091	2	35
Sail	13	4,456	0	00	13	4,456	0	00
Total	52	9,541	2	35	51	9,547	2	35

Increase in tonnage, over 1892, 4,412 tons.
Amount of revenue collected during the year ending December 31, 1893, $326.60.
Greatest draft of vessels, 13 feet.
Value of imports, same year, $3,587.69.
Value of exports, same year, none.
No new lines of transportation established.

O O 4.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

ORIGINAL CONDITION OF THE HARBOR.

In 1818 the mouth of Buffalo Creek was closed by a gravel bar for most of the year. Freshets would at times open a channel, which would be closed later by the lake storms.

PROJECTS FOR IMPROVEMENT.

Private enterprise, assisted later by the State of New York, opened the mouth of the creek and protected that opening by parallel piers. These were built in 1820–'21; the south pier to a length of about 1,300 feet, the north pier 1,000 feet.

In 1825 the Erie Canal was completed to Buffalo, and a first appropriation of $15,000 was made by Congress in 1826 for "building a pier and repairing an old one at the mouth of Buffalo Creek." During the ensuing eight years $90,388 were appropriated in five items for "completing the piers (or 'pier') at Buffalo." By 1833 one pier was 1,790 feet long, the other 1,250; and in 1835 there was a depth of 10 feet in the channel. Various projects were submitted by those in charge or connected with the work between 1830 and 1845. In 1837 a seawall was proposed, to extend about a mile south of the light-house, at an estimated cost of $40,000. Congress adopted the project; gave $48,000 for it in 1838 and $20,500 for "continuing the work at Buffalo."

Work on the sea wall continued until 1840, at which time it was 3,770 feet long.

Appropriations in 1840, 1852, 1853, and 1855, amounting to $54,801.37 maintained existing works, but nothing new was begun. Total appropriated to this date, $262,895.37.

In 1854 a Board of Engineer Officers prepared projects for detached breakwaters to form an outer harbor, but nothing came from its report.

Meanwhile the city dredged Buffalo Creek for an interior harbor, and extended its area in 1848 by digging the "Blackwell Ship Canal" 200 feet wide and 16 feet deep.

During the war lake commerce increased vastly, and in 1863 the total arrivals and departures of vessels at Buffalo reached the largest figures attained, 16,390.

In 1864 an appropriation of $37,500 was made for "repairs and completion of the sea wall." In 1866 and 1867 the sea wall was carried to its ultimate length of 5,400 feet. No further work has been done on it except slight repairs. The piers were repaired with an allotment of $15,000, made in 1865. An appropriation for the harbor of $131,000, made in 1866, and a second in 1867 of $100,000, caused an examination of the question by a Board of Engineer Officers, which reported in 1868:

(1) To extend slightly and thoroughly repair the north pier.
(2) To repair the south pier.
(3) To extend the south pier 318 feet.
(4) To dredge the channel at its entrance; about 12,000 cubic yards.
(5) To build a detached breakwater, beginning at a point in the prolongation of the south pier and 2,500 feet from the light-house, 4,000 feet southwardly, parallel to the shore.

There were two other items proposed which were, however, not approved by the Chief of Engineers. The project outlined above has been carried out.

Difficulties in construction of the breakwater occurred in 1872 and 1873, and the subject was referred to a Board of Engineer Officers, which met in 1873 and 1874 and recommended a catch-sand pier of piling to the 12-foot curve in the lake, and of crib work thence to a total length of 1,270 feet. The detached breakwater was to be built to a total length of 7,600 feet. A shore arm, making an angle of 45° with the shore, was proposed, running from the end of the catch-sand pier, and overlapping the south end of the breakwater, leaving a fair-weather opening of 150 feet between the two structures. This project was approved and is in course of construction.

EXISTING AND AUTHORIZED WORKS.

North pier.—The Delaware, Lackawanna and Western Railroad has unauthorized possession of this pier. A license for their occupation of it was revoked by the Secretary of War on February 20, 1891. The matter was placed in the hands of the Department of Justice in order to have the interests of the United States protected. I am not aware that anything has been done as yet, certainly nothing since I have been here on duty.

Boathouse.—Is in fair condition.

South pier.—It was mentioned in the last report that settlement had occurred in places on the channel side of this pier. One of these places required repair, and for a length of 72 feet the waling pieces and fender piles were removed; the sunken rock dredged, and new piling driven to the rock bottom, and new waling pieces were bolted to the new and old work. This repair was done by day labor at a total cost of $892.52, the material being on hand. There are three other places that shall need similar repairs before long. Otherwise the pier is in good condition.

Breakwater.—At the close of the last fiscal year Mr. J. J. Churchyard, of Buffalo, had sunk five cribs under his contract for the 800 feet extension needed to complete this structure. He pushed his work with energy and judgment, finishing on the 13th October. The extension is in good condition to-day, and the settling has been trifling. This structure has now the full length contemplated, of 7,600 feet, under the project of 1874, the modification of the one of 1868. The first crib was sunk in 1869, the last in 1893, nearly a quarter of a century.

Slight repairs to old work were made in 1893. Two pockets of the portion built in 1873 were empty, their filling having been washed out on the lake side. An outward wall of 12 by 12 inch timbers, set vertically, and well crowded down to the rock at the bottom, was built, and bolted to the lake wall of the superstructure. Then the pockets were filled with large rock and the deck replaced. Similar repairs are now in progress at pockets emptied during the winter. A number of deck plank were replaced, and some 200 4-inch oak plank were spiked as sheathing on the harbor side to cover screw-bolt heads. The material was on hand, the labor was hired, and the total cost was $935.78.

The concrete portion of the breakwater shows no signs of wear or of settlement. Vessels knock off edges in places, and there are a few small holes to be filled ere long.

The timber part is in good condition; minor repairs will maintain it for years.

Shore arm.—At the end of the last fiscal year Donnelly Bros., of Buffalo, had sunk four cribs under their contract for the outward 800 feet of this work. They pushed their work with great energy, and had finished all, save a few pieces of the framing, and all material was on hand at the breakwater, so that but little remained to complete their stretch. On October 14 and 15 there occurred a severe storm from the southwest, which for more than twenty-four hours displayed a wind velocity of over 40 miles per hour, and reached a maximum of 60. During the storm the entire structure of the shore arm was wrecked. The 800 feet of the Donnelly contract, and 350 feet of cribs under the Farnsworth contract, making 1,150 feet in all of crib work, broke through the thin "hard pan" of the lake bed, and sank varying amounts, from 4 feet to 22 feet, down through the softer material below. The cribs canted in all directions, inwardly or outwardly, and, in two cases, in the direction of the structure itself. As the cribs of the outer end sank, the rock filling of the superstructure was emptied, and 350 feet broke off in four pieces and floated ashore. The remaining 450 feet of the superstructure of the Donnelly contract yet remain. The Farnsworth contract for 800 feet, next to Donnelly Bros'., inshore, had not been pushed, and when the storm occurred only seven cribs had been sunk and a part of the superstructure built, but none finished. A piece of this, about 50 feet long, was carried ashore; the rest remains, and the cribs are where they sunk. But little change has occurred in the wreck during the winter, though a critical examination has not as yet been made. The greatest sinking and distortion occurred on the outer 400 feet of the Donnelly contract, a portion that had given no sign at any time of weakness in the foundation. This part was only 162 feet distant from the Churchyard extension, which did not suffer and has not sunk since that time.

The borings taken by the Board of 1874 do not seem to have developed the weakness of this line. In point of fact there appears to be a sharp dividing line between the good and bad foundation, and the shore arm appears to have been located on the very northern edge of the bed of the preglacial river formerly running through Buffalo Creek and the "Tifft Farm." Developments made since 1874, and especially those arising in connection with the making of the Lehigh Valley Railroad harbor in South Buffalo, make it probable that there is a width of about 3 miles to the south from the end of the present breakwater, having the same character: A crust of 2, 3, or 4 feet overlying soft material, at least 20 feet thick; then there is a thin layer of hard material (clay probably), good as far as it goes, and beneath this it is again soft mud or clay and sand mixed. The rock is not less than 60 feet deep and not more than 70. Nothing but careful borings can, however, determine the exact character of this foundation. These borings should be made about 500 feet apart on a line from the south end of the breakwater to Stony Point. They can best be made next winter through the ice. Whatever the result, it is clear in my mind that there is a large area here unfitted to sustain on the narrow foundation given it the heavy weight of cribs and superstructure. This weight is applied in the most disadvantageous manner possible for such a foundation, since there is no bond between the cribs. Possibly a continuous structure could sustain itself, but this is not a desirable or a necessary solution of the problem.

Should it prove desirable to extend the breakwater farther in this direction, it is possible that a foundation could be made 75 feet, or more, in width, by the use of mattresses of the ordinary forest tree, in sizes from 1 foot in diameter at the butt to 6 inches at the point, laid in alternate layers for bonding, and well weighted with riprap or smaller rock. Mats thus used can furnish a comparatively flexible, yet really amply stiff, foundation for not too great a weight. If laid in depths not less than 12 feet, storms will not affect them. For the mass of the breakwater concrete bags of large size, deposited plastic, placed end on to the seas, can be used. After allowing ample time for settlement the structure could be built up in layers. Finally the whole can be raised to a level and to the desired height. When finished there would be a structure that would be comparatively permanent, and repairs for displaced bags or for settlement would be easy to make. My own figures give a stable and permanent work at a less cost than that for crib work.

No further construction should be carried on until the question of the foundation and the method to be followed be fully understood.

The cost of strengthening, repairing, and refilling three pockets of the superstructure of the breakwater, of the portion built in 1873-'75, has been $442.18. This work was done in May and June by hired labor. Nearly all of the material used, save spikes and some deck plank, was on hand.

Statement of appropriations and allotments made for improving harbor at Buffalo, N. Y., from May 26, 1826, to the present time.

May 26, 1826	$15,000.00	June 10, 1872	‡$98,485.04
May 19, 1828	34,206.00	March 3, 1873	75,000.00
April 23, 1830	15,488.00	February 23, 1874	20,000.00
March 2, 1831	12,900.00	June 23, 1874	75,000.00
July 3, 1832	10,300.00	March 3, 1875	100,000.00
March 2, 1833	31,700.00	August 4, 1877	85,000.00
June 28, 1834	20,000.00	June 18, 1878	80,000.00
July 7, 1838	*68,500.00	March 3, 1879	100,000.00
June 11, 1844	40,000.00	June 14, 1880	90,000.00
August 30, 1852	14,000.00	March 3, 1881	90,000.00
March 3, 1853	349.05	August 2, 1882	125,000.00
March 2, 1855	452.32	July 5, 1884	100,000.00
June 28, 1864	†15,000.00	August 5, 1886	112,500.00
July 2, 1864	37,500.00	August 11, 1888	225,000.00
June 23, 1866	131,000.00	September 19, 1890	300,000.00
March 2, 1867	100,000.00	July 13, 1892	300,000.00
April 10, 1869	†89,100.00		
July 10, 1870	80,000.00	* Total	2,791,480.41
March 3, 1871	100,000.00		

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* Two appropriations.

† Allotment from general bill.

‡ Includes $23,485.04 which had reverted to the Treasury and was reappropriated.

Money statement.

July 1, 1893, balance unexpended	$321, 871. 37
June 30, 1894, amount expended during fiscal year	247, 604. 64
July 1, 1894, balance unexpended	74, 266. 73
July 1, 1894, outstanding liabilities	1, 050. 00
July 1, 1894, balance available	73, 216. 73
Amount (estimated) required for completion of existing project	146, 223. 17
Amount that can be profitably expended in fiscal year ending June 30, 1896	146, 223. 17

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Breakwater construction.—Begun in 1869; continued as shown in table.

Year.	Length of crib sunk.	Foundation finished.	Superstructure laid.	Total completed length.
	Feet.	*Feet.*	*Feet.*	*Feet.*
1869	150	150		
1870	800	950	400	400
1871	750	1, 711	783	1, 183
1872	425	2, 136	870	1, 853
1873	263	2, 399	231	2, 048
1874	100	2, 499	415	2, 499
1875		2, 515		2, 515
1876	360	2, 765	200	2, 715
1877	150	2, 915	200	2, 924
1878	150	3, 074		
1879			150	3, 076
1880	350	3, 436	350	3, 426
1881	500	3, 926		
	200	4, 126		
1882	300	4, 437	504 504	4, 437
1883	450	4, 891	454	4, 891
1884	800	5, 696. 9	806. 9	5, 696. 9
1885	450	6, 146. 9	200	5, 896. 9
	200	6, 349. 8	452. 9	6, 349. 8
1891	450	6, 802. 4	452. 6	6, 802. 4
1893	800	7, 608. 7	806. 3	7, 608. 7

In compliance with special instructions from the Chief of Engineers a compilation is making of data for a new edition of the Lake Survey charts covering Buffalo and the head of the Niagara River. To complete this work surveys of certain areas have been made from the head of the river as far south as the southern end of the breakwater.

Great care has been taken to locate the soundings precisely and to collect data for a map that may be of reference for the future to detect changes in the depths of the harbor and its vicinity.

Beginning the second week in April, about three-fourths of the field work was done by July 1. It may be summed thus:

Angles read by transit	2, 407
Verniers read	5, 646
Buoys placed to mark sounding lines	654
Soundings taken	20, 482

COMMERCIAL STATISTICS OF BUFFALO HARBOR, NEW YORK.

Arrivals and departures of vessels for the year ending December 31, 1893.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steamers	3,104	3,913,848	390	136,310	3,289	3,969,875	317	50,744
Sailing vessels and barges	1,179	599,448	643	109,456	1,114	620,525	619	94,443
Total	4,283	4,513,296	1,033	245,766	4,403	4,590,400	936	145,187

Receipts for the years 1890, 1891, 1892, and 1893.

Articles.	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Barley	127,977	104,955	110,423	138,995
Corn	1,279,963	858,876	938,956	1,175,659
Flour	612,067	695,147	955,120	1,035,085
Oats	221,772	199,266	264,004	331,202
Rye	35,886	156,895	36,863	18,049
Wheat	746,059	2.308,379	2,347,307	2,047,313
Flaxseed	75,093	177,030	163,337	136.542
Feed	76,853	89,119	110,671	122,300
Malt	11,585	11,919	8,502	9,391
Oatmeal	1,527	890	3,869	....
Oil cake	38,333	30,653	41,952	20,951
Pease	1,069	6,575	2,015	2.030
Seeds	3,266	3,375	5,599	6,397
Lumber	502,835	459,776	523,215	501,814
Timber	471,450	857.170	630,000	336,000
Laths	8,562	1,378	3,363	3,813
Shingles	8,820	5,380	5,060	6,097
Posts	1,200	2,249	700	168
Ties	14,783	17,893	23,438	18,975
Staves	388	170	....	....
Stave bolts	10,496	14,608	11,840	10,128
Copper	39,636	50,934	34,860	64,930
Copper matte	40,000	26,420	16,950	13,770
Iron ore	551,940	421,890	224,720	243,442
Iron, pig	35,910	30,730	46,160	83,950
Lead, pigs	23,350	27,938	25,309	34,488
Spelter, plates	6,265	5,894	6,202	9,902
Glucose	1,179	12,600	38,310	43,262
Lard	65,010	18,123	20,784	15.559
Pork	5,590	4,821	3,440	1,354
Wool	3,505	13,841	6,954	2,390

Receipts by lake in tons and percentages during the year ending December 31, 1893.

Articles.	Tons.	Percentages.
Barley and malt	148,386	2.3
Corn	1,175,659	18.5
Oats and rye	349,251	5.5
Wheat	2,047,313	32.1
Flour	1,035,085	16.1
Flaxseed, seed, and pease	144,969	2.3
Feed and oil cake	143,251	2.3
Lumber	876,995	13.8
Copper, iron, lead, and zinc	400,482	6.1
Glucose, lard, pork, and wool	62,565	1.0

Shipments by lake from Buffalo Harbor for the years 1890–1893.

Articles.	1890.	1891.	1892.	1893.
	Tons.	*Tons.*	*Tons.*	*Tons.*
Coal	2,157,810	2,365,895	2,852,330	2,703,673
Cement	91,146	81,578	88,936	65,156
Salt	25,260	24,680	21,688	37,361
Railroad iron	34,287	9,055	13,235	7,317
Sugar	....	....	....	119,426

Shipments by lake from Buffalo Harbor, in tons and percentages, during the year ending December 31, 1893.

Articles.	Tons.	Percentages.
Coal	2,703,673	92.18
Cement	65,156	2.22
Salt	37,361	1.27
Railroad iron	7,317	0.25
Sugar	119,426	4.08

Decrease of vessels from last year	824
Decrease of tonnage from last year	56,276
Vessels enrolled at the port of Buffalo in 1893	346
Tonnage enrolled at the port of Buffalo in 1893	178,605.10
Amount of revenue collected at the port of Buffalo in 1893	$753,899.94
Amount of revenue collected at the port of Buffalo in 1892	$877,573.94
Value of exports in 1893	$4,505,375
Value of imports in 1893	$3,270,350

OO 5.

IMPROVEMENT OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK.

Object.—To provide a navigable channel from the entrance to the Niagara River at Lake Erie to the north end of Tonawanda Harbor, and to dredge that harbor to a depth permitting its use by vessels with 16-foot draft.

Project.—To remove obstructions so as to make a channel 400 feet wide and 18 feet deep, which includes work at the following places:

1. On the reef known as "Horseshoe Reef" at the entrance of Niagara River.
2. On the shoal place at the head of Strawberry Island.
3. A few shoal places abreast of the lower end of Rattlesnake Island.
4. The full width of the river between Tonawanda Island and the mainland along the entire front of Tonawanda.

This project was approved in 1888.

Operations during the fiscal year.—Under contract with Hingston & Woods dredging was had at both Strawberry Island and the Horseshoe Reef. At the former place a very careful survey was made in April and May, 1893, in which the soundings were taken at points 25 feet apart, marked by tags on lines stretched from two scows securely anchored on either side of the channel. The positions of the scows were frequently obtained by transit readings from the shore. The entire length of the intended channel was thus gone over, and then the dredge dug the material from the limited areas found not to have the full depth of 16 feet desired for the first dredging. In this way 3,150 cubic yards of sand, clay, and gravel, measured in place, and 125 cubic yards of rock were excavated. In addition to this a dredge and tug were employed six hours removing a spot in the channel excavated in prior years.

Total cost of this:

3,150 cubic yards sand, clay, and gravel, at 70 cents	$2,205.00
125 cubic yards rock, at $3.70	462.50
6 hours' dredging, at $7	42.00
6 hours' tug hire, at $3	18.00
Total	2,727.50

The channel at Strawberry Island is now 400 feet wide, and has the full depth of 16 feet. The next step will be to deepen it to 18 feet. Three buoys were placed by the light-house department on the east side of this channel in the fall of 1893, and no reports reach me of any trouble in this vicinity when vessels keep the channel.

Horseshoe Reef.—The drill boat and one dredge were at work on the two principal shoals here at the beginning of the fiscal year. A second dredge was set at work August 10, 1893, and these three machines worked during the season when the weather permitted. The drill stopped work October 19. The dredges continued till November 29. As only a portion of this is reported in my last year's report, I will give here the entire results of the season:

Hours' work of drill-boat in 1893	2,165¼
Holes drilled and blasted	2,620
Hours of dredges	1,683½
Cubic yards dredged and dumped, scow measure	12,500
Total earnings of contractors during the season	$37,307.25

In 1894 the area to be dredged, and that had been dredged, was very carefully surveyed in April, 2,400 soundings having been taken 12½ feet in one direction and 16 feet apart in the other. The first week in May a dredge was set on the central shoal, and continued on it during the remainder of the year, dredging 3,320 cubic yards rock measured in the scow. This shoal is almost entirely removed, only the final cleaning up remaining. In the second week in May a drill boat was placed on the western shoal spot and has continued on it till the close of the year. For 1894 the work may be summarized thus:

Hours' work of drill boat, May and June	714¼
Holes drilled and blasted	968
Hours of dredges	439
Cubic yards dredged and dumped, scow measure	3,320
Total earnings of contractors in 1894	$11,274

An obstacle with only 12 feet of water on it that had been struck by the steamer *Newaygo* has been located in the main channel about 1,000 feet above the inlet pier. It was buoyed, and an attempt will be made to remove it. A sounding scow was made under contract, costing $633, for use on the river, and proves to be a great convenience.

Statement of appropriations made for improving Tonawanda Harbor and Niagara River, from August 11, 1888, to the present time.

August 11, 1888	$100,000
September 19, 1890	75,000
July 13, 1892	75,000

Money statement.

July 1, 1893, balance unexpended		$73, 263. 49
June 30, 1894, amount expended during fiscal year		45, 853. 32
July 1, 1894, balance unexpended		27, 410. 17
July 1, 1894, outstanding liabilities	$6, 953. 00	
July 1, 1894, amount covered by uncompleted contracts	18, 492. 00	
		25, 445. 00
July 1, 1894, balance available		1, 965. 17
Amount (estimated) required for completion of existing project		1, 008, 090. 16
Amount that can be profitably expended in fiscal year ending June 30, 1896		200. 000. 00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for sounding scow, opened by Maj. E. H. Ruffner, Corps of Engineers, at Buffalo, N. Y., at 2 p. m., January 20, 1894.

No.	Name and address of bidder.	Amount of bid.	Remarks.
1	Union Dry Dock Co., by Edward Gaskin, superintendent, Buffalo, N. Y.	$633. 00	Guarantee incomplete.
2	Wilson E. Skinner, Buffalo, N. Y	1, 100. 00	
3	Riley and Bowen, Buffalo, N. Y	1, 725. 55	
4	The Mills Dry Dock Co., by Hamilton J. Mills, treasurer, Buffalo, N. Y.	1, 200. 00	Only 2 proposals.
5	George B. Drake, Buffalo, N. Y	1, 125. 00	

Bid No. 1 is recommended for acceptance.
Balance available, $34, 494.

Abstract of proposals for the hire of dredges and a drill boat, for use on the Niagara River, opened by Maj. E. H. Ruffner, Corps of Engineers, at Buffalo, N. Y., February 8, 1894, in response to advertisement of January 8, 1894.

No.	Name and address of bidder.	Prices bid.
1	Hingston & Woods, Buffalo, N. Y	Dredge, $56; drill boat, $56, and tug $24 per 8-hour day.

No other bids received.

Amount available	$34, 000
Allotment	30, 000

COMMERCIAL STATISTICS OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK.

Vessels entered and cleared during the year ending December 31, 1893.

Entered from home ports	848
Entered from foreign ports	61
Cleared from home ports	839
Cleared from foreign ports	55
Entered	909
Cleared	894
Entered and cleared	1, 803
Duties collected on foreign lumber	$8, 048. 59

Number of vessels and rafts passing the international bridge in the years 1890–1893.

1890	12,351
1891	13,202
1892	14,044
1893	11,641

The decrease of the passing vessels in 1893 is attributed to the labor troubles at Tonawanda, and to the diversion of pleasure traffic from Grand Island to Lake Erie resorts.

Principal receipts during the year ending December 31, 1893.

Articles.	1893.	1892.	1891.
	Tons.	*Tons.*	*Tons.*
Lumber	752,936	871,508	884,646
Shingles	3,031	5,137	6,307
Lath	3,308	1,561	2,052
Railroad ties	5,152	21,333	8,092
Iron ore	66,617	85,772	70,840
Pig iron	1,460	1,440	2,850
Pulp wood	15,770	900	....
Limestone	15,824	10,374	....

Total receipts in tons and percentages during the year ending December 31, 1893.

	Tons.	Per cent.
Lumber, shingle, lath, and ties	764,427	88.5
Iron ore and pig iron	68,077	7.8
Pulp wood	15,770	1.8
Limestone	15,824	1.9

O O 6.

IMPROVEMENT OF NIAGARA RIVER FROM TONAWANDA TO PORT DAY, NEW YORK.

An appropriation of $20,000 was made for this improvement in the river and harbor act of 1892. The project is based upon a preliminary report made by Major Stickney on February 28, 1892, found in House Doc. 67, Fifty-second Congress, first session. The limitation to 6 feet depth of proposed channel, as given in the act, really altered the intent and project of the survey and made an incidental estimate the main feature, which has proved not to be a practicable scheme, since the navigation of boats drawing more than 6 feet has been established since the date of the survey between Buffalo and Schlosser Dock, within a mile of Port Day, of the bill, and at the upper end of property owned by one corporation as far down as Port Day.

It has been shown by a special report that a channel of 12 feet depth can be established to this dock by passing to the west of Grand Island and excavating only through the shoal at the head of Conners Island, for the sum of $80,000; and it is further shown that an additional expenditure of $149,749 would make an inside route from Tonawanda to this point which would accommodate vessels drawing not more than 12 feet of water. It seemed unadvisable to expend the $20,000 on the lesser-depth channel, and hence, under the authority of the Secretary of War, the matter was held for the further action of Congress.

Money statement.

July 1, 1893, balance unexpended	$20,000.00
July 1, 1894, balance unexpended	20,000.00
Amount (estimated) required for completion of existing project	470,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	80,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Port Day for the year ending December 31, 1893.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steamers	233	47,610	2	440	233	47,610	2	440

Greatest draft of vessels .... feet .. 7

O O 7.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

Object.—To obtain a 12-foot channel from Twelve-mile Creek to Lake Ontario..

Project.—The present project was submitted in 1873, and proposes to extend piers to the 12-foot curve in the Lake Ontario, and to dredge a channel 12 feet deep between the piers, and for a width of 100 feet from the shore end of the piers to the deep water in the creek.

Present works.—The piers are prolongations of piers built by private parties in 1846. At present the west pier is 832 feet long and the east pier is 850 feet long. There is also a shore protection for the east pier. This is 360 feet long, The channel has an available depth of 9.5 feet for a width of 100 feet from the west pier.

CONDITION OF THE WORKS.

For several years a detailed estimate has been submitted of the repairs needed to put the piers in good condition. This estimate aggregated $13,364.20. Should an appropriation be made for this harbor it would not be wise to expend it in continuation of the original project before making these repairs. Probably the estimate made in 1890 would not cover the needed repairs to-day, and not less than $15,000 would be needed for this purpose.

The channel.—This remains in fairly good condition for the craft which can pass it, but as this is only 8.5 feet no mercantile vessel can use the harbor. The dredging operations developed a quantity of rock greater than was looked for when the project was made, and an estimate of 4,200 cubic yards of rock, in place, was made of the amount to be removed before the 12 feet desired could be secured. In addition to this is an increasing amount of sand accumulating constantly in the channel. No dredging has been done since 1889, when nearly 25,000 yards were removed.

Estimated cost of work.—In order to complete the present project there remain—

4,200 cubic yards rock excavation, at $3 per cubic yard	$12,600
700 cubic yards dredging, at 30 cents per cubic yard	210
	12,810
Contingencies (10 per cent)	1,281
	14,091

But, as the needed repairs to the piers exceed this amount, an appropriation, intended to complete the project and repair the piers, should include the $15,000 additional required for the second, or main, item. The whole work could be done in one season, and the amount necessary to put the port in the condition intended when its improvement began is $29,091.

There being no funds on hand, nothing is intended at present.

Statement of appropriations.

March 3, 1875	$10,000
August 14, 1876	10,000
June 14, 1880	10,000
March 3, 1881	10,000
August 2, 1882	10,000
August 5, 1886	10,000
August 11, 1888	5,000
Total	65,000

Money statement.

July 1, 1893, balance unexpended	$21.49
July 1, 1894, balance unexpended	21.49
Amount (estimated) required for completion of existing project	13,978.49
Amount that can be profitably expended in fiscal year ending June 30, 1896	29,091.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Arrival and departure of vessels for the year ending December 31, 1893.

Vessels.	Arrivals from foreign ports.		Departures to foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	47	17,746	47	17,746
Sailing vessels	5	368		
Total	52	18,114	47	17,746

Amount of revenue collected during the year ending December, 1893	$410.55
Value of exports same year	$33.00
Value of imports same year	$2,848.00
Increase of tonnage same year	7,920
Greatest draft of vessels ... feet	9

Vessels enrolled at this port, none.

New lines of transportation established, none.

Principal imports, lumber; principal exports, fruit.

O O 8.

IMPROVEMENT OF OLCOTT HARBOR, NEW YORK.

Object.—To obtain a protected channel 13.5 feet deep at mean lake level from Lake Ontario to the bridge crossing Eighteen Mile Creek at Main street.

Project.—The first project for this work was submitted in 1846, but it was not executed. The present project was adopted in June, 1891, and is substantially the project of 1866, with some enlargements. It provides for two piers extending into the lake, with a channel between them. The piers are nearly parallel to each other, about 200 feet apart. The east pier is 850 feet long and the west pier 873 feet. Between the piers the channel is about 180 feet wide, the limiting lines being 10 feet from the piers, and from the shore end of the piers it decreases to 98 feet in width at the Main street bridge. The channel depth is 13.5 feet, measured from mean lake level.

Present works.—East and west piers and the channel between them.

Condition of works.—Both piers are in good condition, and the channel has the full depth between the limits as given.

Proposed operations.—The project for this harbor is completed, and the remaining funds will be used for maintenance.

Statement of appropriations made for improving harbor at Olcott, N. Y., from March 2, 1867, to the present time.

March 2, 1867	$60,000	March 3, 1875	$10,000
July 11, 1870	10,000	March 3, 1881	3,000
March 3, 1871	5,000	August 5, 1886	10,000
June 10, 1872	10,000	August 11, 1888	5,000
March 3, 1873	10,000	September 19, 1890	30,000
June 23, 1874	10,000		
		Total	163,000

Money statement.

July 1, 1893, balance unexpended	$5,436.23
June 30, 1894, amount expended during fiscal year	60.00
July 1, 1894, balance unexpended	5,376.23
July 1, 1894, outstanding liabilities	16.00
July 1, 1894, balance available	5,360.23

COMMERCIAL STATISTICS.

Arrival and departure of vessels for the year ending December 31, 1893.

Vessels.	Arrivals from foreign ports.		Departures to foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*
Steamers	2	580	2	580
Sailing vessels	4	267	4	267
Total	6	847	6	847

Amount of revenue collected during the year ending December, 1893	$12.25
Value of imports same year	$25.00
Greatest draft of vessels ... feet	9

Principal imports, potatoes; principal exports, fruit.

O O 9.

IMPROVEMENT OF OAK ORCHARD HARBOR, NEW YORK.

Object.—To furnish a protected channel 200 feet wide and 12 feet deep from deep water in the Lake Ontario to deep water in Oak Orchard Creek.

Project.—The original plan for this improvement, adopted in 1836, consisted in contracting the mouth of the creek to 200 feet by two breakwaters running from the shore, one on each side, and a channel between two parallel piers from the 12-foot curve in the creek to the same curve in the lake. This project, except as to the breakwaters, is still in force.

Present work.—The present works are the east and west piers and a shore protection. The piers extend to the 12-foot curve in the lake. The shore protection, beginning at the shore end of the east pier, was built in 1889, and is 91 feet long. The channel has a depth of 13.5 feet at mean lake level for the whole width between the piers, excepting 10 feet along each pier.

Condition of the works.—The east pier and the shore protection are in good condition and need but slight repairs. The west pier has settled for a length of 130 feet about 2½ feet on the harbor side, where the pier intersects the shore line; also, on the outer end toward the lake. Both settlements were caused by very rough weather in the fall of 1891, during the low stage of water, 2.2 feet below mean lake level, undermining those places. The channel is in good condition.

Proposed operations.—The project of this harbor has been completed, but a certain amount of money should be appropriated to keep it in repair.

Statement of appropriations made for improving harbor at Oak Orchard, N. Y., from July 4, 1836, to the present time.

July 4, 1836	$5,000	August 14, 1876	$2,000
March 3, 1837	5,000	June 18, 1878	2,000
July 7, 1838	5,000	March 3, 1879	1,000
June 11, 1844	5,000	June 14, 1880	500
August 30, 1852	10,500	August 2, 1882	3,000
March 2, 1867	87,000	July 5, 1884	5,000
July 11, 1870	8,000	August 5, 1886	12,500
March 3, 1871	10,000	August 11, 1888	6,000
June 19, 1872	2,500	September 19, 1890	5,000
March 3, 1873	10,000		
June 23, 1874	10,000	Total	205,000
March 3, 1875	10,000		

Money statement.

July 1, 1893, balance unexpended	$492.34
June 30, 1894, amount expended during fiscal year	30.00
July 1, 1894, balance unexpended	462.34
July 1, 1894, outstanding liabilities	8.00
July 1, 1894, balance available	454.34

COMMERCIAL STATISTICS FOR OAK ORCHARD, N. Y.

Arrivals and departures of vessels for the year ending December 31, 1893.

Vessels.	Arrivals from foreign ports.		Departures to home ports.	
	No.	*Tons.*	*No.*	*Tons.*
Sailing vessels	4	239	4	239

Amount of revenue collected during the year ending December 31, 1893	$231.30
Value of imports same year	$2,373.00
Greatest draft of vessels ... feet	12

Principal imports, lumber, laths, shingles, and posts.

O O 10.

REPORT OF BOARD OF ENGINEERS ON HARBOR LINES AT SQUAW ISLAND, NIAGARA RIVER, NEW YORK.

ARMY BUILDING,
New York, July 16, 1894.

GENERAL: The Board of Engineer Officers appointed by Special Order No. 27, Headquarters, Corps of Engineers, dated May 29, 1894, to consider and report upon the proposed docks at Squaw Island, Niagara River, has performed the duties assigned it and has now the honor to submit the following report:

The Board assembled at Buffalo on June 18, 1894, present all the members, and held a duly advertised public meeting at the engineer office in that city. The record of proceedings is appended, marked (AA*).

During the recess the Board, accompanied by Maj. E. H. Ruffner, Corps of Engineers, the officer in charge of the district, inspected the site of the proposed docks and noted the velocities and flow of the currents in the vicinity. The draw of the International bridge is situated adjacent to the island. The draw span next the shore is shoal and large vessels are compelled to make use of the other span at present. This difficulty, it is claimed, will be removed by the dredging necessary to open a passage way to the proposed docks.

The only reason for apprehending obstruction to navigation from the proposed docks arises from this unfortunate position of the draw. Vessels lying at the pier heads might occupy space needed for safe passage. Moreover, the current of the river sweeping past the docks will render dropping down and swinging into the slips a slow process, and while so doing the vessels might interfere with tows approaching the draw from above. Careful inquiries were made as to this matter of river men present at the meeting and others familiar with St. Lawrence navigation, and the opposing interests represented appeared to be satisfied that, with the shortening of the piers near the bridge indicated on the accompanying drawing, no serious interference with the shipping interests below the island need be feared.

So far as navigation is concerned the whole matter resolves itself into establishing harbor lines along the river side of Squaw Island. In order to define such lines a survey of the site was necessary. Such a survey has been made by Major Ruffner on application of this Board. The accompanying drawing is based on this survey, which indicates also the piers and slips desired by the company and the modifications considered by the board to be needful to carry into effect the views above stated. The definite arrangements of piers and slips proposed by the company have not been considered, it being deemed that all reasonable demands of navigation will be met by restricting the length and mode of construction by the condition that no extension of solid filling beyond the designated bulkhead line, and no extension of open pier work beyond the designated pier-head line, shall be permitted. The following is the proposed definition of these two lines, which are also clearly shown on the accompanying drawing:*

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*Omitted.

DEFINITION OF PIER-HEAD AND BULKHEAD LINES.

The bulkhead line defines the limit beyond which solid filling may not be extended. The pier-head line defines the limit to which open-piled structures may be built.

Bulkhead line.—Starting from the axis of the International bridge prolonged (said to make an angle with the true meridian of north 76° 8′ 30″ east), and at a distance of 230.6 feet from the west face of the abutment pier on the American side and measuring distances in a southerly direction on a straight line there drawn perpendicular to said bridge axis prolonged, the bulkhead line recommended for approval follows a straight course from the eastern face of the abutment pier to a point 769.9 feet distant from said axis, 285.5 feet distant from said straight line; thence it extends in a straight course to a point 1,770 feet distant from said axis and 219.6 feet from said straight line; thence it extends in a straight course to a point 2,494.8 feet distant from said axis and 112 feet from said straight line; thence following a straight course in prolongation of the last-named extension it extends to the southern boundary prolonged of the property on Squaw Island owned by the Niagara River Hydraulic Company.

Again starting from the point above defined on the axis of the International bridge prolonged, and measuring distances as before, but in a northerly direction, the bulkhead line recommended for approval follows a straight course from the eastern face of the abutment pier to a point 747.5 feet distant from said axis and 165 feet distant from said straight line; thence it extends to a point distant 1,319.9 feet from said axis and 247.3 feet from said straight line; thence it extends to a point distant 1,796.7 feet from said axis and 283 feet from said straight line; thence it extends to a point distant 2,096.7 feet from said axis and 223 feet from said straight line; thence it follows a straight course in prolongation of the last-named extension to the northern boundary prolonged of the property on Squaw Island owned by the Niagara River Hydraulic Company.

Pier-head line.—Except as hereinafter specified, the pier-head line recommended for approval lies on a straight line perpendicular to the axis of the International bridge at its intersection with the axis of the eastern rest pier along the entire front of the property on Squaw Island owned by the Niagara Hydraulic Company.

For a distance of 675 feet on each side of the axis of the International bridge said pier-head line lies on a straight line perpendicular to said axis at a point measured on said axis 50 feet to the eastward of the axis of the rest pier of the draw. From the two terminal points thus determined the pier-head line recommended for approval lies on straight lines extended to two points respectively lying on the general pier-head line above defined at distances of 1,250 feet from the axis of the International bridge.

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* Omitted.

With this report is a tracing* of the survey made by Major Ruffner, showing the bulkhead and pier-head lines recommended for approval; also the record of proceedings* of the Board, marked AA, with 9 accompanying documents,* marked respectively from A to I inclusive; also a blue print* showing the international bridge, furnished to the Board by Major Ruffner, marked BB.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
C. B. COMSTOCK,
Colonel of Engineers,
Bvt. Brig. Gen., U. S. A.
DAN C. KINGMAN,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 20, 1894.

Respectfully submitted to the Secretary of War.

The Board of Engineers, constituted by authority of the Secretary of War to consider and report on the application of the Niagara River Hydraulic Company for permission to construct docks at Squaw Island, submits the within report, to which, and to its accompanying papers, attention is respectfully invited.

The Board is of the opinion that the questions presented by the application can better be met, so far as the demands of navigation are concerned, by the establishment of harbor lines along the river side of Squaw Island, thus restricting the length and mode of construction of the proposed docks, by the condition that no extension of solid filling beyond the designated bulkhead line and no extension of open pier work beyond the designated pier-head line, shall be permitted.

The Board has accordingly caused a survey to be made, and presents the accompanying drawing, on which are delineated the bulkhead and pier-head lines recommended for adoption.

I concur in the views expressed by the Board, and recommend that the harbor lines be approved, and that the Secretary place his approval both upon this report and upon the drawing.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *July 23, 1894.*

Approved, as recommended by the Chief of Engineers.

DANIEL S. LAMONT,
Secretary of War.

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* Omitted.

APPENDIX P P.

IMPROVEMENT OF HARBORS ON LAKE ONTARIO EAST OF OAK ORCHARD, NEW YORK.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Charlotte, N. Y.
2. Pultneyville Harbor, New York.
3. Harbor at Great Sodus Bay, New York.
4. Harbor at Little Sodus Bay, New York.
5. Oswego Harbor, New York.
6. Harbor at Sacketts Harbor, N. Y.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., July 10, 1894.

GENERAL: I have the honor to transmit herewith * * * my annual report for the following works in my charge.

* * * * * * *

I have the honor to be, very respectfully, your obedient servant,

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

P P 1.

IMPROVEMENT OF HARBOR AT CHARLOTTE, NEW YORK.

OBJECT.

To secure a navigable channel at the mouth of the Genesee River on Lake Ontario.

Charlotte Harbor is the port of the city of Rochester, which is situated 2 miles above the head of the navigable part of the river forming the harbor.

PROJECT.

1829.—To obtain a channel 480 feet wide and 12 feet deep, formed and protected by parallel piers extending to deep water of the lake, executed in 1834.

1881.—To secure and maintain, by pier extension and dredging, a channel of navigable width and 15 feet depth at extreme low water. No dredging has heretofore been done, the channel having been formed and kept open with 12 feet depth by the current of the Genesee River.

The following appropriations have been made for this work:

May 23, 1828	$300.00
March 2, 1829	10,000.00
March 3, 1829	13,335.00
March 2, 1831	16,670.00
February 24, 1832	16,000.00
March 2, 1833	15,000.00
June 28, 1834	20,000.00
March 3, 1835	2,390.00
July 2, 1836	20,000.00
March 3, 1837	10,000.00
July 7, 1838	25,000.00
June 11, 1844	10,000.00
August 20, 1852	20,000.00
March 3, 1853	176.10
June 28, 1864	25,000.00
June 23, 1866	75,607.30
July 25, 1868, allotment	1,100.00
April 10, 1869, allotment	$1,000.00
July 11, 1870	12,000.00
March 3, 1871	10,000.00
March 3, 1875	5,000.00
June 18, 1878	1,000.00
March 3, 1879	1,000.00
June 14, 1880	5,000.00
March 3, 1881	2,500.00
August 2, 1882	35,000.00
July 5, 1884	20,000.00
August 5, 1886	26,250.00
August 10, 1888	45,000.00
September 19, 1890	25,000.00
July 13, 1892	25,000.00
Total	494,328.40

PRESENT WORKS.

The piers which define and maintain the channel are formed of cribs of timber, 20 feet wide and 30 feet long, sunk end to end in as close contact as practicable by filling with loose stone.

The cribs forming the original work were built of logs hewed flat, and were allowed to settle into the natural sand bottom upon which they were placed, each crib having 2 to 4 oak guide piles driven on each side of it to keep the crib in line while settling into the sand. A continuous timber superstucture was then built upon the cribs for the full width of 20 feet, and 3 to 5 feet in height above the mean lake level. The whole was then filled with loose stone and decked with 3-inch plank. The cribs being below water and not subject to decay were built of hemlock timber, fastened together with tie heads and driftbolts, while the continuous superstructure was built of white pine timber and plank similarly fastened. The latter has a life of about 15 years.

(*1*) *West pier.*—This has a total length of 3,622 feet, in addition to a shore return of 137 feet. It is composed of the following parts:

Section A, from the shoulder angle of the return at the shore line of 1829, 554 feet northward toward the lake. It was built in 1829 and last repaired in 1867. Owing to the fact that the shore line has advanced beyond it further repairs are not considered necessary.

Section B, 564 feet long, built in 1829–1834 and last repaired in 1885 by the Ontario Beach Improvement Company, by whom it is used as a wharf. It is within the present shore line.

Section C, 1,402 feet long, built in 1829–1834 and last repaired in 1887–'88.

Section D, 235 feet long, built in 1829–1834 and last repaired in 1891.

Section E, 303 feet long, built in 1883, not since repaired.

Section F, 365 feet long, built in 1893, not since repaired.

(*2*) *East Pier.*—This has a total length of 2,896 feet, in addition to an abandoned shore connection 402 feet in length, upon which the superstructure has not been removed since its original construction in 1829–1834, and which is now destroyed to nearly the level of the surrounding bottom, only its guide piles showing above low water. The width was originally 20 feet throughout, the substructure being of separate cribs and the superstructure of continuous timber work, similar in detail to the west pier. It is composed of the following parts:

Section A, 325 feet long, measuring toward the lake, built in 1829–1834, last repaired in 1867. It is well within the shore line, and further repairs by the United States are not considered necessary. The superstructure was renewd in 1894 by the Summerville Beach Improvement Company.

Section B, 100 feet long, built in 1829–1834, last repaired in 1887 by the U. S. Life-Saving Service, of whose station it forms the water front.

Section C, 225 feet long, built in 1829–1834, last repaired in 1889.

Section D, 797 feet long, built in 1829–1834, last repaired in 1886–1887.

Section E, 995½ feet long, built in 1829–1834 and last repaired in 1890.

Section F, 303 feet long, built in 1883 and not since repaired.

Section G, 150½ feet long, built in 1884–'85 and not since generally repaired.

CHANNEL.

The original project of 1829 proposed to obtain a channel 480 feet wide and 12 feet deep, protected by parallel jetties, and extending from deep water within the mouth of river to deep water in the lake. It was entirely successful; the channel was formed and maintained with the desired depth by the scouring action of the river alone from the time of building the jetties in 1829.

But in 1881, in compliance with the increasing demands of commerce, it was proposed to secure and maintain, by extending the jetties and dredging, a channel 15 feet deep at extreme low water. No dredging had ever been necessary to maintain the 12-foot depth. In pursuance of this enlarged project some 1,220 feet of jetties have been built, which, however, does not extend them to the required depth in the lake, and a large amount of dredging has been done.

The first dredging was done in 1888, and it was continued as means were provided until the fall of 1892. About 270,000 cubic yards of material, mostly sand, were removed, and a channel, 380 feet wide throughout and not less than 15 feet deep at extreme low water was formed between the jetties. Fifty years' experience had conclusively shown that the river could not of itself remove this material. Now that it had been dredged out it remained to be seen whether the current would be sufficient to keep it from filling up again.

The results of a recent survey at this place would seem to answer this question in the negative. The Genesee River has been subject to very unusual floods during the past spring. It has overflowed its valley, eroded its banks extensively, and even shifted its channel in places. Consequently its water has been loaded with silt, a part of which has been deposited in the jetty channel, and a very material shoaling has been the result. The fill has amounted to more than 4 feet in places, and the channel is seriously impaired. There is still a navigable waterway of not less than 15 feet at the ordinary summer stages of the lake, but the quantity of material deposited between the jetties can not be less than 60,000 cubic yards.

In view of the fact that this is a silt-bearing stream for at least two or three months of the year, and has very little current for the remaining nine or ten months, it would perhaps be too much to expect that a 15-foot channel as wide as 380 feet could be maintained without periodical dredging. The 1881 project is silent upon this point.

The river above the drawbridge, where its condition is remarkably stable, has a width of about 300 feet, a maximum depth of about 27 feet at the present stage of water and an average depth of something over 17 feet, and an area of cross section of about 5,500 square feet. This shows how large a channel the river can create and maintain for itself. The channel between the jetties had, after dredging, an area of cross section of about 7,500 square feet. Filling in would seem inevitable if the river brings down much silt.

It seems necessary, therefore, to decide now whether, in order to carry out the existing project, resort shall be had to periodical dredging, or to some suitable contraction of the channel between the jetties by the construction of spurs, as was done at the South Pass of the Mississippi River and elsewhere.

OPERATIONS.

The work of extending the west jetty was in progress at the beginning of the fiscal year. Four cribs of an aggregate length of about 480 feet had been built, and the foundation had been prepared by dredging a trench about 40 feet wide and 4 feet deep and filling it with stone. All of this had been done during the previous season. The cribs were moored in the river during the winter. Some labor had been necessary to protect them from the ice during the spring freshet. They suffered no injury, however. The prepared foundation was carefully sounded, and when necessary it was leveled up by the addition of more stone. During the month of July the first crib was successfully sunk. The other cribs rapidly followed, the last one being put in place on the 25th of August. On the morning of the 29th of August, before the work of filling the last crib was completed, a storm of almost unprecedented violence occurred, which wrought great damage to property on the lakes.

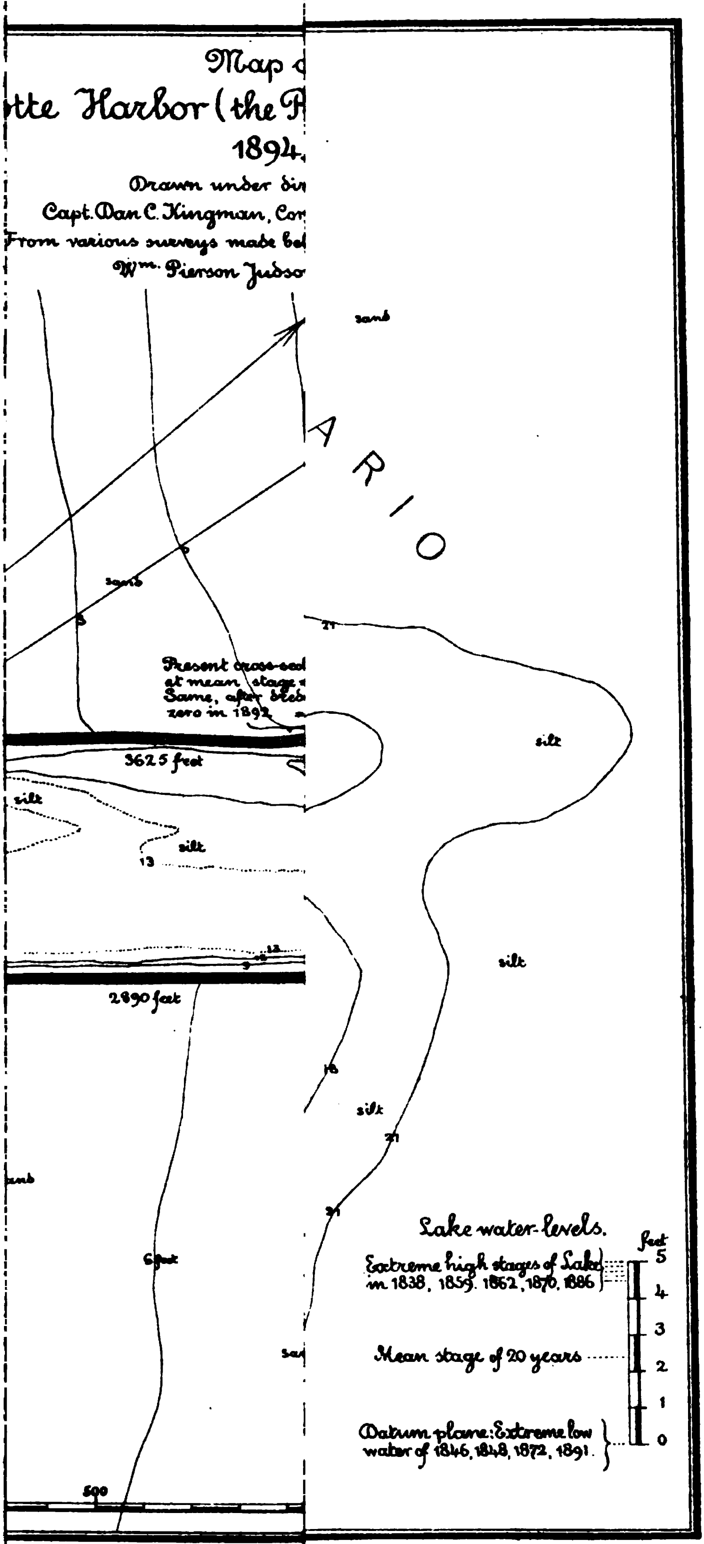
The last crib contained at this time 543 cubic yards of stone and furnace slag. But this weight proved insufficient to hold it. The wind blew first from the northeast and then shifted suddenly to the northwest and the sea was very high. The crib finally yielded to the force of the waves, the sides and interior braces were torn loose from the grillage which formed the bottom, the timbers were cracked and split about 50 feet from the shore end, and the crib was lifted off the grillage and floated up the river, where it was caught and secured.

An examination of the bottom where the crib had been sunk indicates that the grillage is still in place, and shows that the stone filling of the crib has been so leveled off by the waves that it will form no obstruction to replacing the crib.

The crib itself is generally sound, except about 50 feet from the inner end where the side and interior longitudinal timbers are pretty badly cracked. These timbers can be fished and the crib turned over in the water and a new grillage bottom placed in it.

This was not attempted last fall. A superstructure of the approved form was built on the 3 remaining cribs, thus forming an extension of the west jetty of 365 feet.

A recent inspection of this piece of work shows that it is standing in perfect line and without any appreciable settlement.



The Friedenwald Co. Photo-Lith. Balto. Md. **Eng. 53 3.**

Minor repairs were made to the jetties when needed, broken planks being replaced, etc. And on the 22d of October work was suspended for the season.

During the month of June, 1894, numerous soundings were made in the channel between the jetties, in the mouth of the river, and in the lake in the vicinity. The results have been plotted upon a map, which is submitted, and it is recommended that it be published in the Annual Report.

There has been expended for labor and material in connection with this work, $7,873.77; for engineering and office expenses, $1,564.31; for the examination and survey, $124.21, and $600 for services of watchman, who also read the gauge and collected the commercial statistics.

REMARKS.

I would recommend that the jetties be extended, according to the project, to the 15-foot contour as rapidly as the means provided will allow, and I would also recommend that the method of maintaining the prescribed depth of 15 feet at low water between them be fully considered and made the subject of a definite project.

The choice must be between periodical dredging and channel contraction, for the present width is so great that the river current can not of itself maintain the required depth of 15 feet.

It is proper to invite attention to the fact that the United States has constructed some 7,057 linear feet of jetty work at this place, of which 4,975 is valuable and necessary to the maintenance of the harbor. The rest of it has been absorbed by the advance of the shore line, and further repairs will probably not be required.

Five thousand feet of jetty in round numbers, therefore, must be kept in good order. As elsewhere explained it is composed of timber cribs filled with stone. The part that is below the general level of the water it not subject to decay, and only needs repairs when it is damaged by collisions or storms—accidents of infrequent occurrence.

But the timber that is above water and which forms the superstructure is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it might give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $11 a running foot. There is now 605 feet of it here that is more than eleven years old. It needs renewal, and will cost $6,666. This sum is not included in the amount required to complete the existing project.

Name of harbor, Charlotte, New York, collection district, Genesee, N. Y. (at Charlotte). A fixed light of the fourth order on crib 380 feet inside of outer end of west pier. A range light of three fixed lights, 2 red and 1 white, 60 feet high, at inner end of west pier.

Forts Niagara and Ontario, N. Y., are the nearest works of defense.

Money statement.

July 1, 1893, balance unexpended	$12,793.93
June 30, 1894, amount expended during fiscal year	10,162.29
July 1, 1894, balance unexpended	2,631.64
Amount (estimated) required for completion of existing project	109,650.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	75,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Charlotte Harbor, New York, during fiscal year ending June 30, 1894.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	440	64,734	33	4,212	88	32,485
Foreign	241	113,170	213	43,310	138	47,494
Total	681	177,904	246	47,522	226	79,979
American owned	232	66,502	32	4,967	178	64,306
Canadian owned	449	111,402	214	42,555	48	15,673

Sum total, 1,153 arrivals; 305,405 registered tonnage.

DEPARTURES.

Home	445	69,221	30	3,433	72	27,145
Foreign	233	108,486	216	44,081	151	51,721
Total	678	177,707	246	47,514	223	78,866

Sum total, 1,147 departures; 304,087 registered tonnage.

Greatest draft of vessels .... feet.. 16
Greatest tonnage of vessels .... registered tonnage.. 1,613
Greatest load of vessels .... net tons.. 1,814

Receipts and shipments by lake at Charlotte Harbor, New York, during fiscal year ending June 30, 1894.

Trade.	Receipts.							Shipments.				
	Passengers.	Grain.	Merchandise.	Live animals.	Poles and ties.	Posts and wood.	Lumber, etc.	Passengers.	Merchandise.	Grain.	Oil.	Coal.
		Net tons.	*Net tons.*	*Net tons.*	*Net tons.*	*Net tons.*	*Net tons.*		*Net tons.*	*Net tons.*	*Net tons.*	*Net tons.*
Home on lake	6,172	3,459	525	2	229	......	470	5,940	535	......	......	137,045
Foreign on lake	10,312	412	66	......	1,409	3,957	3,100	9,451	......	43	102	195,934
Total	16,484	3,871	591	2	1,638	3,957	3,570	15,391	535	43	102	332,979

Navigation closed December 5, 1893; navigation opened April 5, 1894.

For the purpose of reduction to tons weight, the following is assumed, viz: Seven barrels of oil equal 1 ton; 20 crates of fruit equal 1 ton; 4 live animals equal 1 ton; 1,000 feet lumber equal 1½ tons; 1 cord wood and posts equal 1½ tons; 12 railroad ties and poles equal 1 ton.

P P 2.

IMPROVEMENT OF HARBOR AT PULTNEYVILLE, NEW YORK.

OBJECT.

To furnish a protected channel of navigable width and not less than 10 feet depth at the mouth of Salmon Creek, Wayne County, N. Y., which is situated 21 miles east of the Genesee River.

PROJECT.

The present project of 1872 provides for a breakwater running 330 feet eastward from the west side of the creek, a west pier or jetty thence northward into the lake, and an east pier or jetty about 200 feet eastward from the west pier and parallel to it; also a dredged channel between the piers and behind the breakwater, and extending about 400 feet up the creek.

After this work was done, at a total expenditure of $71,000, it was found that the waves from the lake, when driven by a gale from the northwest, would strike the east pier in such a way as to be reflected upon the beach within the harbor, and that in receding they would sweep the gravel and sand from the beach into the excavated channel along the harbor side of the breakwater, where it would lodge across the mouth of the creek.

Accordingly it was further proposed in 1884, in order to make dredging of permanent value and effect, to build a sand-tight structure 500 feet in total length parallel to the breakwater and about 100 feet from it, between it and the harbor beach, so as to arrest this movement of material.

A part of this structure was built in 1892.

The following appropriations have been made for this work:

May 23, 1828, an act appropriating for survey of shore between Oswego and Charlotte, with a view to improvement of harbors $400

July 11, 1870	$5,000	March 3, 1879	$4,000
March 3, 1871	5,000	June 14, 1880	3,000
June 10, 1872	10,000	March 3, 1881	2,000
March 3, 1873	10,000	August 2, 1882	4,000
June 23, 1874	10,000	September 19, 1890	2,000
March 3, 1875	10,000	July 13, 1892	1,000
August 14, 1876	3,000		
June 18, 1878	5,000	Total	74,000

PRESENT WORKS.

West breakwater.—This has a total length of 330 feet, and is formed as follows:

Section A, from the west shore line eastward 150 feet in length and 15 feet in width, formed by cribs of flatted round logs built at local expense before the General Government undertook the improvement of the harbor in 1867, $30,000 having been thus expended before that year. It was last repaired by the United States in 1877, but is now in a half-ruined condition. It received some trifling repairs in 1893.

Section B, 180 feet long, built by the United States in 1871, has not since been repaired, and is very much decayed above water level.

West pier.—Has a total length of 558½ feet, and consists of the following parts:

Section A, 222 feet long, built in 1874-'75, and not since repaired.

Section B, 93½ feet long, built in 1880; no subsequent repairs.

Section C, 183 feet long, built in 1881, and repaired slightly in 1884.

Section D, 60 feet long, forms the end of this pier, built in 1883; not since repaired. The outer end has been breached and much stone has escaped. It will soon be destroyed unless the end is rebuilt.

East pier.—This has a total length of 571½ feet; it was built between the years 1872-1880, and consists of the following parts:

Section A, beginning 140 feet from the shore line (at the end of a private wharf, since destroyed) and extending 85½ feet northward into the lake. It was built in 1880, and has not since been repaired.

Section B, 62 feet long, built in 1877, and not since repaired.

Section C, 30 feet long, built in 1877, and not since repaired.

Section D, 92 feet long, built in 1873, and not since repaired.

Section E, 180 feet long, built in 1872, and not since repaired.

Section F, 122 feet long, built in 1873, and not since repaired.

In all these sections the cribs are sound, but the superstructure needs renewal, without which the whole will be wrecked.

Sheet piling.—Of the structure to arrest sand drift from the harbor beach to the channel into the creek, which was proposed in 1884, 200 linear feet, from the east side of the creek outlet eastward toward the land end of the east jetty, was built in 1891-'92. The structure is sand-tight, being formed of the Wakefield patent sheet piling. Its oak wale pieces are below the line of no decay, and they are tied back by iron rods to logs buried in the bottom, upon which the accretion will probably form, so that the structure may be expected to be a permanent one. It of itself produced an effect in causing a scour of the shoal between it and the breakwater, but dredging was necessary to make a navigable channel. Experience shows that this bulkhead is not wholly efficient in its incomplete condition. It seems desirable to extend it, in accordance with the project, as rapidly as the money supplied will allow.

CHANNEL.

Dredging was done in 1873, 1875, and 1880, to secure a channel of navigable width and about 9 feet deep between the jetties along the west breakwater and several hundred feet up the creek. The channel was not permanent throughout its length, but at two or three points it shoaled rapidly, particularly at the mouth of the creek, at the entrance to the inner harbor. Here the depth in every case was soon reduced to 2 or 3 feet. This was due to the washing of sand from the harbor beach by waves that struck the shore obliquely.

It was to stop this drift of material that the sand-tight bulkhead was erected. The fact that it of itself caused a deepening of this portion of the channel encourages the belief that it will fully protect the cut that has since been formed by dredging. The bulkhead, however, is hardly long enough, being only about 200 feet in length, and there is still some shoaling to the east of it, near the shoulder angle of the breakwater.

OPERATIONS.

No operations of any consequence were possible during the year, because no money was available.

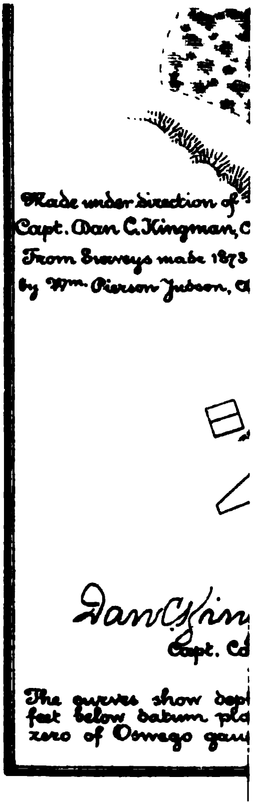
The channel was examined during the month of June, 1894. It showed that the portion protected by the sand-tight bulkhead, and also that within the mouth of the creek, was maintaining itself in a satisfactory manner, while the remaining portion evinced a tendency to fill with sand, thus showing that the bulkhead in its unfinished condition was not wholly effective.

A map of this harbor has been prepared embodying the results of this survey, and is submitted with the recommendation that it be published with the Annual Report.

REMARKS.

The entire superstructure of the works at this place is in a most wretched condition. The marvel is that it has held together so long. One thousand four hundred and sixty linear feet of piers and jetties have been built here by the United States, all of which is valuable and necessary to the maintenance of the harbor.

As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below the general level of the water is not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subject to decay, and only needs repairs when it is damaged by collisions or storms, accidents of infrequent occurrence.

But the timber that is above water and which forms the superstructure is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired; otherwise it might give way in a severe storm, and great damage result to the whole structure. The cost of the superstructure of the kind used here is about $11 a running foot.

All of this superstructure is more than eleven years old, and most of it is over twenty.. It will cost to renew it $15,000, in round numbers. This sum is not included in the amount given as required to complete the existing project.

Name of harbor, Pultneyville, N. Y. Collection district, Genesee, N. Y. Nearest light-house, Great Sodus, New York. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1893, balance unexpended	$62.91
June 30, 1894, amount expended during fiscal year	38.24
July 1, 1894, balance unexpended	24.67
Amount (estimated) required for completion of existing project	9,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	9,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Pultneyville Harbor, New York, during fiscal year ending June 30, 1894.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.	
	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	3	131	16	230
Foreign, on lake			7	404
Total	3	131	23	634
American owned	3	131	18	414
Canadian owned			5	220

Sum total, 26 arrivals 765 registered tonnage.

DEPARTURES.

Home, on lake	3	131	16	262
Foreign, on lake			6	296
Total	3	131	22	558

Sum total, 25 departures; 689 registered tonnage.

Greatest draft of vessel	feet	8
Greatest tonnage of vessel	registered tonnage	76
Greatest load of vessel	tons	97

Receipts and shipments by lake at Pultneyville Harbor, New York, during fiscal year ending June 30, 1894.

Trade.	Receipts.				Shipments.		
	Passengers.	Merchandise.	Lumber, etc.	Posts and wood.	Passengers.	Fruit.	Merchandise.
		Net tons.	*Tons.*	*Cords.*		*Tons.*	*Tons.*
Home, on lake	40	63	255	198	58	....	....
Foreign, on lake	....	5	12	93	....	....	6
Total	40	68	267	291	58	....	6

For the purpose of reduction to tons weight the following is assumed: Barrels oil, 7 equal 1 ton; M lumber, 1 equals 1½ tons; crates of fruit, 20 equal 1 ton; railroad ties and poles, 12 equal 1 ton; cords wood and posts, 1 equals 1⅓ tons; live animals, 4 equal 1 ton.

Navigation closed December 5, 1893; navigation opened April 5, 1894.

P P 3.

IMPROVEMENT OF HARBOR AT GREAT SODUS BAY, NEW YORK.

OBJECT.

To secure a navigable channel from Lake Ontario to Great Sodus Bay with a depth of 15 feet.

Great Sodus Bay is 5 miles long, 2 to 3 miles wide, is deep and landlocked, and is situated midway between Oswego and the Genesee River. It is the coal-shipping port on Lake Ontario for the Pennsylvania Railroad.

PROJECT.

1828.—To contract the entrance to Great Sodus Bay to 470 feet by breakwaters extending from east and west shores and to define and protect a channel 470 feet wide by piers extending to deep water in Lake Ontario.

1882.—To extend the piers to the 15-foot curve in the lake and to dredge the channel between them to 15 feet depth at extreme low water.

The following appropriations have been made for this work:

May 23, 1828, an act appropriating for survey of shore between Charlotte and Oswego with a view to improvement of harbors $400.00

March 2, 1829	$12,500.00	June 23, 1874	$15,000.00
March 3, 1829	15,280.00	March 3, 1875	10,000.00
March 2, 1831	17,450.00	August 14, 1876	5,000.00
February 24, 1832	17,000.00	June 18, 1878	5,000.00
March 2, 1833	15,000.00	March 3, 1879	2,000.00
June 28, 1834	15,000.00	June 14, 1880	3,000.00
March 3, 1835	11,790.00	March 3, 1881	5,000.00
July 2, 1836	12,600.00	August 2, 1882	25,000.00
March 3, 1837	12,000.00	July 5, 1884	10,000.00
July 7, 1838	10,000.00	August 5, 1886	16,875.00
June 11, 1844	5,000.00	August 10, 1888	24,000.00
August 20, 1852	10,000.00	September 19, 1890	10,000.00
June 23, 1866	53,151.80	July 13, 1892	15,000.00
March 2, 1867	80,000.00		
July 11, 1870	5,000.00	Total	452,646.80
June 10, 1872	15,000.00		

PRESENT WORKS.

The project has been completed, except that the east jetty lacks 800 feet of reaching the curve of 15 feet at extreme low water, and that the channel has not been dredged to 15 feet for its full width.

The dredging formerly done at this place (which has been quite large in amount) was all done parallel to and near the west jetty. The drifting sand upon this side of the jetties has formed an enormous deposit, building out the shore in front of the west breakwater and against the west jetty. This sand is carried over the jetty by the wind, and perhaps through it to some extent by the waves, and in this manner has found its way to the channel. It is estimated that not less than 142,000 cubic yards of sand was carried into the space between the jetties from 1870 to 1892. Most of the sand falls near the west jetty at its inner end. Therefore the dredging done last year was upon a line crossing the channel diagonally from the outer end of the west jetty to the inner end of the east one. It is found that this work is more permanent.

The piers and jetties which contract the entrance and define and shelter the channel were originally built in 1829–1834. They were started from the west and the east sides of the entrance naturally about 4,000 feet wide, and were extended toward the center where they were continued northward by parallel jetties, 470 feet across the 8-foot bar, from deep water in the bay to deep water in the lake.

These piers and jetties defining and sheltering the channel were built in 1829–1834, and were composed of cribs of timber, each 18 feet wide and 30 feet long, sunk end to end upon the natural sand and gravel bottom in as close contact as practicable by filling them with loose stones.

The cribs were formed of logs hewed flat, framed together and bolted with iron driftbolts and wooden treenails. They appear to have had floors of slabs, and were allowed to settle into the natural sandy bottom for part of the season before building upon them the continuous superstructure of hewed timber. These old cribs, in part or whole, are still in place and are sound below mean water level.

The different portions of the work may be described as follows:

West breakwater.—This has a total length of 2,200 feet. It was built 18 feet wide, with a superstructure of same width in 1829–1834.

The cribs were each 18 feet wide and 30 feet long, and starting at the beach line gradually increased in depth to 8 feet, where they joined the jetty.

Section A, 1,693 feet long from the west shore eastward, built in 1829–1834, has never been repaired, and was long since covered by the accretion of the beach, and its maintenance is now unnecessary. Section B, 241 feet long, built in 1829–1834. It has never been repaired by the United States, and its condition is the same as the preceding section. Its superstructure was, however, repaired by the owner of the adjacent land in 1888.

Section C, 266 feet long, built in 1829–1834, and last repaired in 1877–'78.

West jetty.—This is 1,580 feet long and 18 to 20 feet wide, as follows:

Section A, from the shoulder angle northward 975 feet, built in 1829–1834, and last repaired in 1877 and 1880.

Section B, 285 feet long, built in 1829–1834, and last repaired in 1889.

Section C, 134 feet long, built in 1869, and last repaired in 1889.

Section D, 185 feet long, built in 1883. It has received no general repairs since, but in 1891 it was renewed at the outer end in consequence of injuries it had received from a barge striking it.

East breakwater.—This has a total length of 1,651 feet from Charles Point, on the east side of the bay, westward to join the east jetty. It is made up as follows:

Section A, from Charles Point westward 215 feet, built in 1884, and not since repaired.

Section B, 511 feet long, built in 1829–1834, and last repaired in 1877–'78.

Section C, 415 feet long, built in 1829–1834, and last repaired in 1877–'78.

Section D, 172 feet long, built in 1829–1834, and last repaired in 1870.

Section E, 264 feet long, built in 1829–1834, western 81 feet, repaired in 1891, the rest not since 1876.

Section F, 74 feet long, to east jetty, built in 1829–1834, and last reired in 1891.

East jetty.—This is 1,291 feet long from its junction with the east breakwater northward to the 10½-foot curve of extreme low water in the lake. Its details are as follows:

Section A, from the angle of the breakwater 440 feet northward, built in 1829–1834, and last repaired in 1891.

Section B, 500 feet long, built in 1834, last repaired in 1890.

Section C, 154 feet long, built in 1883, and not since repaired.

Section D, 200 feet long, built in 1885, and not since repaired.

In 1877 50 running feet of sheet piling was driven along the west jetty northward from a point 150 feet north of the shoulder angle with a view to make it sand-tight. In 1877–1888 this work was extended 612 feet. It all consisted of 4 by 12 inch oak plank, 20 feet long, strengthened by a 6 by 12 inch oak wale-piece, bolted through into the crib timbers.

To arrest sand movement into the channel there was also built in 1877 and 1880, upon the west sand beach, where it has formed again against the west jetty, a system of overlapping sand-catch fences of a total length of 760 feet. These fences have been effective, but they can not be maintained beyond high-water line, and there is generally a wide space of sand between them and the water, from which the prevailing westerly wind blows the sand across the jetty. This is the source from which comes a considerable portion of the sand which tends to refill the channel.

These fences are not very durable and are troublesome to keep in repair, and this season an effort has been made to induce a growth of willow trees which will in time take the place of the fences. About 800 good-sized trees were planted in the spring of 1893.

A recent inspection shows that they are nearly all alive and have made good growth.

CHANNEL.

1829.—The space, 470 feet wide, between the jetties had a natural depth of 8 feet in October, 1829. This was the actual depth at that time when the water level must have been at least 1 foot and was probably 2 feet above extreme low water, this being the average stage of lake level at this time of year. No plane of reference of lake level was established until 1837, when the present accepted extreme low-water level was determined at Oswego and fixed as the zero of the gauge, whose readings have since been daily observed in feet and hundredths above this zero. The records of channel depths in the various reports are much confused during recent years as well as formerly by variously stating the depths as at ordinary low-water level, or at ordinary water level, or as the actual depth at a given date. In this report all such reference will be reduced to the plane of extreme low-water level without comment.

1836.—The first dredging was done at Great Sodus Harbor in 1836, and was continued during 1837 and 1838, $45,390 being thus expended.

1838.—The result was to form a channel 100 feet wide, 1,500 feet long with 11½ feet depth, by removing about 30,000 cubic yards of gravel and sand.

1844.—In August, 1844, this channel was found to have shoaled to 9 feet depth.

1856.—The next dredging was done in 1856, when 6,233 cubic yards of sand was removed at a cost not stated.

1867.—Nothing more was done until 1867, when renewal of the jetty was begun and dredging was done under its shelter; 9,200 cubic yards were then dredged at 24 cents per yard.

1868–'69.—The dredging was continued in 1868 and 1869, completing a channel by removing about 40,000 cubic yards additional.

1870.—In 1870 the sand had again drifted into this 200-foot channel to such an extent as to reduce it to 8 feet depth for its west half and 4 to 5 feet depth for its east half, the undredged eastern 270 feet of the space between the jetties varying from 2 feet at the inner end to 7 feet at the outer end.

1873.—In 1873, 19,000 cubic yards of sand were removed, at 35 cents per cubic yard, measured in position, again making the channel 9 feet deep for 150 feet next the west jetty, and this was continued in—

1874.—By removing 44,977 cubic yards of sand, at 22½ cents, scow measurement, and again making the 200-foot channel 9 to 11 feet deep.

1881.—No further dredging was done until 1881, when the channel had again shoaled to a governing depth of 8 feet, and dredging was resumed.

1882.—During 1881 and 1882, 42,050 cubic yards were removed, at 23 cents per cubic yard, in scows, making a channel 2,300 feet long, 120 feet wide next the west jetty, and 11½ feet deep.

1886.—In 1886 dredging was again needed, and 13,224 cubic yards were removed, at 16 cents per yard, making a channel 50 feet wide and 12 feet deep.

1887.—In 1887 the depth was again reduced to 9 feet, and a centrifugal pump was employed to take the sand from the channel and deliver it on the other side of the west jetty. Thirteen thousand cubic yards of sand were thus removed, at 12½ cents per cubic yard, making 10¼ feet depth for 50 feet width.

1889–'90.—In 1889 and 1890 a dipper dredge was again employed; 40,942 cubic yards of sand, gravel, and cobblestones were removed, at 18 cents per cubic yard, scow measurement, and a navigable channel was again made 100 feet in width, 2,000 feet long, and 15 feet deep, located 30 feet from the west jetty.

1892.—In 1892 this cut had again shoaled to 8¾ feet, and the United States dredging plant was employed during the month of June in deepening it. Eleven thousand two hundred and nineteen cubic yards of sand were removed at this time.

All of this serves to show that the channel has been a troublesome one to maintain; and this, as before stated, has been largely due to the extensive beach to the westward, from which the sand is carried by the wind over the jetty and dropped into the channel.

A comparison of the results of a survey made in 1870 with those of another similar survey made in 1892, by the same assistant engineer, indicates that not less than 142,000 cubic yards of sand has found its way into the channel in this manner. This would be at the rate of about 6,500 cubic yards a year, which does not seem an unreasonable amount to one who has seen the clouds of sand that are lifted by every westerly gale. In 1877–'80, sand fences were erected to stop this drift. They have no doubt been of considerable service; but it has not been possible at all times to keep them in thorough repair, and they are not sufficient in extent to entirely effect their purpose.

Last year about 800 good-sized willow trees were planted, and it is hoped that as they grow they will prove much more durable and efficient than the sand fences.

Owing to this tendency of the channel to fill up near the inner end of the west jetty, all dredging subsequent to 1892 has been upon a line that runs diagonally from the outer end of the west jetty to the inner end of the east one.

1893.—During the fiscal year ending June 30, 1894, 94,071 cubic yards have been removed along the new line; 50,106 yards, scow measure, were dredged under contract at 11½ cents a yard, and the remainder by the plant owned by the United States at about the same actual cost.

OPERATIONS.

As only about $2,400 was available for this work at the beginning of the fiscal year, but little could be undertaken. The United States dredging plant was engaged here at the beginning of the year in deepening the channel. It was kept here until August 10, when work was suspended, owing to lack of funds. During this period 16,379 cubic yards of sand was removed from the channel at a cost of $1,834.49, or at the rate of 11⅕ cents a cubic yard.

During the month of June, 1894, the channel was carefully sounded. The results show that the sand between the jetties has been to some extent leveled off by the action of the waves and currents, whereby the depth in the dredged cut has been reduced in the narrowest part to about 13 feet at extreme low water, or 15½ feet at the present stage of the lake. This result is to be expected until the great body of the sand has been removed from between the jetties.

From the notes of the survey a map has been prepared which shows much better than any existing one the present conditions. It is submitted with the recommendation that it be published in the Annual Report.

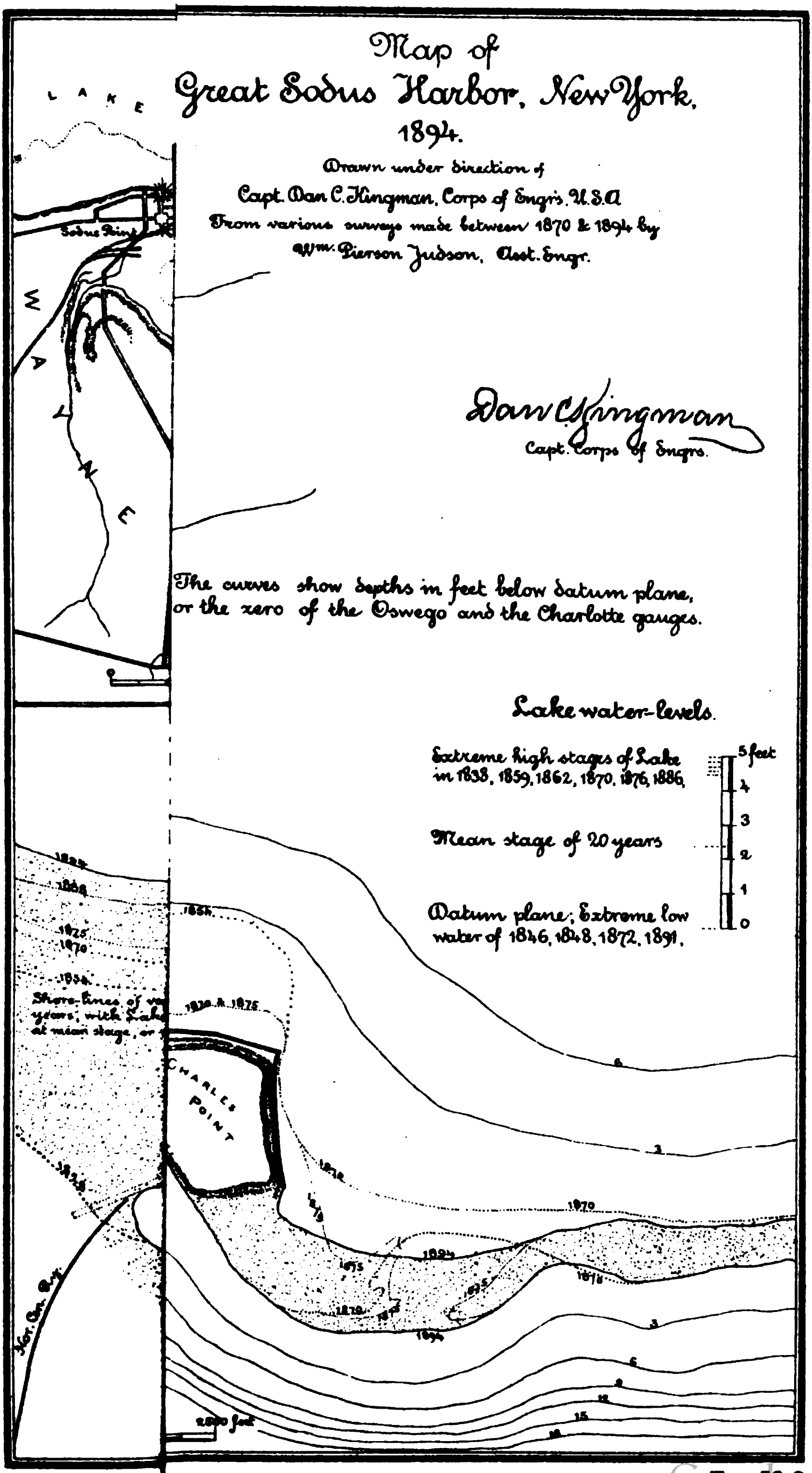
REMARKS.

In regard to this channel I think that the piers should be extended to the 15-foot depth as rapidly as possible, and the channel should be dredged to its full width in the manner before described.

It is proper to invite attention to the fact that the United States has constructed some 8,722 linear feet of jetties and breakwaters at this place, of which 6,788 feet is valuable and necessary to the maintenance of the harbor. The rest has been absorbed by the advance of the shore line, and further repairs to it will probably not be required.

Six thousand eight hundred feet of jetty work, in round numbers, therefore must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below water is not subject to decay, and only needs repairs when it is injured by collisions or storms, accidents of unfrequent occurrence.

But the timber which is above water and which forms the superstructure is in a situation very unfavorable to its durability.



Map of Great Sodus Harbor, New York, 1894.

Drawn under direction of
Capt. Dan C. Kingman, Corps of Engrs. U.S.A.
From various surveys made between 1870 & 1894 by
Wm. Pierson Judson, Asst. Engr.

Dan C. Kingman
Capt. Corps of Engrs.

The curves show depths in feet below datum plane, or the zero of the Oswego and the Charlotte gauges.

Lake water-levels.

Extreme high stages of Lake in 1838, 1859, 1862, 1870, 1876, 1886.

Mean stage of 20 years

Datum plane; Extreme low water of 1846, 1848, 1872, 1891.

Shore-lines of va
years, with Lake
at mean stage, or

The Friedenwald Co., Photo-Lith., Balto., Md.

Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it is liable to give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $11 a running foot. There is now 1,426 feet of it here that is from eleven to sixteen years old. It needs renewal now, and will cost $16,000. This sum is not included in the amount required to complete the existing project.

Name of harbor, Great Sodus Bay, New York. Collection district, Oswego, N. Y. Nearest light-house, Big Sodus, New York; a fixed white light of the fourth order, varied by a white flash every two minutes, on a bluff three-fifths mile west of the entrance to the bay; a fixed white light of the sixth order 180 feet inside of the outer end of the west pier, and a fixed red light of the sixth order at elbow of west pier.

Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1893, balance unexpended	$3,610.39
June 30, 1894, amount expended during fiscal year	3,578.40
July 1, 1894, balance unexpended	31.99
Amount (estimated) required for completion of existing project	43,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Great Sodus Harbor, New York, during fiscal year ending June 30, 1894.

ARRIVALS.

Trade engaged in	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	28	1,348	34	1,246	6	1,730
Foreign, on lake	4	336	37	5,292	8	2,034
Total	32	1,684	71	6,538	14	3,764
American owned	29	1,389	5	570	8	2,082
Canadian owned	3	295	66	5,968	6	1,682

Sum total, 117 arrivals; 11,986 registered tonnage.

DEPARTURES.

Trade engaged in	Steamers. Number.	Steamers. Registered tonnage.	Sailing vessels. Number.	Sailing vessels. Registered tonnage.	Barges. Number.	Barges. Registered tonnage.
Home, on lake	31	1,546	31	1,113	10	2,753
Foreign, on lake	3	214	39	5,518	4	1,011
Total	34	1,760	70	6,631	14	3,764

Sum total, 118 departures; 12,155 registered tonnage.

Greatest draft of vessel	feet..	11½
Greatest tonnage of vessel	registered tons..	336
Greatest load of vessel	net tons..	664

Receipts and shipments by lake at Great Sodus Harbor, New York, during fiscal year ending June 30, 1894.

Trade.	Receipts.					Shipments.			
	Passengers.	Merchandise.	Grain.	Poles and railroad ties.	Lumber.	Passengers.	Lumber.	Merchandise.	Coal.
		Net tons	*Net tons*	*Tons.*	*Tons.*		*Net tons*	*Net tons*	*Net tons*
Home, on lake	546	5	557	....	....	582	606	....	997
Foreign, on lake	....	....	....	40	....	....	....	18	12,054
Total	546	5	557	40	....	582	606	18	13,051

Navigation closed November 20, 1893. Navigation opened April 8, 1894.

For the purpose of reduction to tons weight the following is assumed:

Barrels oil, 7 equal 1 ton; M lumber, 1 equals 1¼ tons; crates fruit, 20 equal 1 ton; railroad ties and poles, 12 equal 1 ton; cords wood and poles, 1 equals 1¼ tons; live animals, 4 equal 1 ton.

P P 4.

IMPROVEMENT OF HARBOR AT LITTLE SODUS BAY, NEW YORK.

OBJECT.

To secure a channel from Lake Ontario into Little Sodus Bay of navigable width and of depth not less than 15 feet at extreme low water.

Little Sodus Bay is 2 miles long, three-fourths of a mile wide, is deep and landlocked, and is situated midway between Oswego and Great Sodus, or 13 miles west of Oswego. It is the coal-shipping port on Lake Ontario for the Lehigh Valley Railroad.

PROJECT.

To contract by breakwaters the entrance to the bay to a width of 250 feet and maintain a channel 200 feet wide and 15 feet deep at extreme low water by parallel piers.

The following appropriations have been made for this work:

May 23, 1828, an act appropriating (for survey of shore between Charlotte and Oswego with a view to improvement of harbors) $400.00

August 20, 1852	$10,000.00	August 14, 1876	$5,000.00
April 9, 1864	1,778.36	June 18, 1878	10,000.00
April 9, 1864	2,224.00	March 3, 1879	5,000.00
April 9, 1864	99.00	June 14, 1880	20,000.00
June 23, 1866	33,840.41	March 3, 1881	20,000.00
March 2, 1867	50,000.00	August 2, 1882	25,000.00
April 10, 1869	1,500.00	July 5, 1884	10,000.00
July 11, 1870	5,000.00	August 5, 1886	12,500.00
March 3, 1871	15,000.00	August 10, 1888	16,000.00
June 10, 1872	15,000.00	September 19, 1890	13,000.00
March 3, 1873	15,000.00	July 13, 1892	6,000.00
June 23, 1874	15,000.00		
March 3, 1875	10,000.00	Total	316,941.77

PRESENT WORKS.

The project has been completed, except that the west and the east jetties lack 200 feet and 465 feet, respectively, of reaching the 15-foot curve and that the whole of the channel between the jetties has not been dredged to 15 feet, 12 feet at extreme low water being the governing depth.

A narrow channel was dredged through the hardpan bar last fall, in which there is a depth of not less than 15 feet at low water. This channel is about 40 feet wide, and is parallel to the west jetty and about 30 feet from it.

With this exception the undredged part of the channel is the outer 500 feet of the space between the present jetties and 200 feet additional beyond the end of the west jetty. The material is tough hardpan, requiring blasting before it can be dredged.

The breakwaters and jetties which contract the entrance and define and shelter the channel were begun in 1854, though the works now forming the harbor were built since 1867. They consist of crib-work breakwaters extended from the west and the east sides of the entrance (naturally 2,500 feet wide in 1867) upon the gravel bar, which is characteristic of this and of all the bays on the south shore of Lake Ontario.

The breakwaters were built to the sides of the natural cut through the bar (which was 1¼ feet deep in 1853 and 5½ feet deep in 1866) and were thence extended north to deep water in the lake by parallel jetties 250 feet apart.

These structures were formed of cribs each 20 feet wide and 30 feet long, sunk end to end upon the natural bottom in as close contact as practicable by filling them with loose stone gathered from the shores of the bay and lake and by dredging gravel and dumping it into them.

The cribs were formed of sawed hemlock timber 12 inches square and 10 by 12 inches, which was framed together and bolted with iron bolts. The cribs had tight plank floors, and the earlier ones were allowed to settle into the natural gravel and sand bottom for part of the season before building the continuous superstructure of 12 by 12 inch pine timber, also filled with loose stone. For the later cribs a foundation was prepared by dredging a trench or by depositing riprap.

At each side of the bay the junction of the breakwaters with the shore was effected by stake and fascine structures, intended to aid the accretion of drift.

The different portions of the work are described as follows:

In every case where depth of water is mentioned in this report the depth at extreme low-water level, or at the zero of the Oswego gauge, is meant.

(1) *West breakwater.*—The original structure was built in 1868, and was a peculiar one, specially designed for this place. It was of triangular cross section, with 13 feet base and 13 feet sides, built in separate sections, 25 feet long, of 6 by 6 inch hemlock frames, planked inside with 2-inch hemlock plank, the whole filled with loose stone and sunk upon the crest of the bar at a depth of half a foot to 2 feet. Its total length from the west shore to the west jetty was 650 feet. The breakwater was built in 1868 and was destroyed the same year.

In 1870-'71 the present rectangular crib-work structure, 469 feet long and 10 feet wide, was built 30 feet outside of and parallel with the original one. It is still in place, though much decayed. All but 90 feet adjoining the west jetty is buried beneath the accretion of the west beach, and this 90 feet was repaired in 1887.

(2) *West pier or jetty.*—This is 1,960 feet long and 20 feet wide, extending across the bar north to deep water in the lake.

The structure is made up of the following parts:

Section A, 186 feet long, which was built in 1854. It has never been repaired. A beach having formed outside of it, it is no longer necessary to maintain.

Section B, 50 feet long, built in 1854, last repaired in 1867.

Section C, 860 feet long, built in 1867–'68, last repaired in 1889.

Section D, 150 feet long, built in 1870–'71, last repaired in 1889–'90.

Section E, 242 feet long, built in 1881, has not been renewed.

Section F, 272 feet long, built in 1883, has not been repaired.

Section G, 200 feet long, built in 1885, has not been repaired.

(3) *East breakwater.*—This is 1,850 feet long, consisting of 1,680 feet of shallow crib work, is 20 feet wide, placed upon the crown of the bar, in depth varying from half a foot above extreme low water to 2½ feet below the same plane. It extends from near the east side of the bay to the east jetty, its junction with the east shore being effected by 170 feet of stake and fascine work.

Its details are as follows:

Section A is 170 feet long and 8 feet wide, and was built in 1885 from the east shore to the crib-work breakwater, which it joins 50 feet west of the east end.

It consists of stakes and wire-bound fascines, made from the trunks and branches of hard-wood brush, the whole paved with stone gathered from the lake shore. It has stood without attention and is covered by the accretion of sand and gravel.

Section B is 150 feet long and 20 feet wide, and was built in 1878, forming the east end of the breakwater. It has not since been renewed, except its western 50 feet, which was included in the portion rebuilt in parapet form in 1891.

Section C, 750 feet long, built in 1875, last repaired in 1891.

Section D, 540 feet long, built in 1874, last repaired in 1889–'90.

Section E, 240 feet long, built in 1873, last repaired in 1889–'90.

East jetty.—This is 1,510 feet long from the west end of east breakwater across the bar to 11½ feet of water in the lake. It is parallel to the west jetty, and 250 feet from it. The details are as follows:

Section A, 512 feet long, built in 1872–'73, last repaired in 1887.

Section B, 757 feet long, built in 1881–'82, has not been renewed.

Section C, 241 feet long, built in 1883, has not been repaired.

Section D. This jetty still lacks about 500 feet of its proposed length.

A full history of this work was published in the Annual Report of the Chief of Engineers for 1892.

CHANNEL.

Prior to beginning the construction of jetties there was no permanent natural channel across the bar which closed the entrance to the bay.

The general width of this bar from deep water within the bay to deep water in the lake outside was from 600 to 900 feet between 6-foot curves, about 2,000 feet between 12-foot curves, and 2,600 feet between 15-foot curves. These and all depths stated in this report are at extreme low-water level, which coincides with the plane of zero of the Oswego gauge, which was established at extreme low-water level in 1837.

The natural depths upon the crest of the bar and in the channel across it varied from time to time.

In 1828 and in 1845 the crest of the bar was above water for most of the distance across the bay, the channel (at the same place as the present one) being stated in the Annual Report for 1847 "to have but 2 feet of water. If this meant the actual depth, which seems probable, its reduction to extreme low-water level would give but half a foot.

In 1853, just before the first jetty construction, the depth was 1¼ feet below extreme low water, which was in 1854 increased by dredging under the shelter of the west jetty to 6 feet. The amount of material then removed to make the channel, which appears to have been about 450 feet long and 80 feet wide, must have been about 4,000 cubic yards.

In 1866, when the next work of improvement was begun, a detailed survey showed this cut to be 5½ feet deep.

Dredging in the channel was resorted to in 1868–'69, and again in 1871, and sufficient material was removed from the channel to secure a depth of 10 feet between the jetties.

In 1875, a shoal about 100 feet wide had formed across the channel by sand drift around the outer end of the west jetty, which then extended only to the 9-foot curve. This shoal had 8 feet depth, and 1,592 cubic yards were dredged from it at 25 cents per cubic yard to make a passage 80 feet wide next to the west jetty. An exceptionally high stage of water prevailed in the lake in 1876, and no further dredging was done until 1879, when deepening the channel to 15 feet depth at extreme low water was begun. During 1879 and 1880 and 1881 there were removed 25,931 cubic yards of gravel, sand, and mud, at 18 cents per cubic yard, scow measurement, and the work was continued in 1881 at 17¾ cents per yard. At the latter rate 43,562 cubic yards, scow measurement, were removed up to December 1, 1881, making 15 feet depth at extreme low water for 200 feet width and 1,700 feet length. This carried the excavation out as far as the west jetty then extended, 242 feet beyond the light-house pier head. The jetty was extended 472 feet farther in 1883 and 1885, but no attempt was made to extend the excavated channel, as the fact was developed that the material composing the remainder of the bar was a tough hardpan, instead of gravel and sand, as the rest had been, and money for its removal was not available, 20,000 cubic yards being the excavation required to make 15 feet depth, the estimated cost being $1 per cubic yard.

In 1891 the space between the jetties had gradually shoaled to about 12 feet by the deposit of loose sand and mud.

In 1891 7,257 cubic yards of sand and 541 cubic yards of hardpan was removed from between the jetties by the United States dredging plant; and in 1893, 12,590 cubic yards of sand and 1,777 yards of hardpan were removed by the same means, with the result, as before stated, of making a narrow channel of the required depth through the hardpan bar to deep water in the lake.

OPERATIONS.

The United States dredging plant was sent to Little Sodus on the 11th of August, 1893, and began work at once. It is here that the hardpan bottom is found. It lies near the outer end of the jetties, forming a bar across the entrance, upon which there is but 12 feet depth at low water. The width of the bar is 800 feet. The material is too hard to be dredged economically. A good dredge can only get up 30 or 40 yards a day, and to do this the dipper has to be armed with very large and powerful steel teeth, and these wear down so fast that they have to be taken off and sharpened every second day. To assist the dredge in breaking up this hard material, resort was had to surface blasting. High-grade Atlas powder was used in charges of 25 pounds. It was feared that larger charges would injure the jetties. The cartridges that made up the charge were placed together in a bag, sunk to the bottom in the proper place, and fired by an electric exploder. The explosions all seemed to be sharp and complete, and the water tamping, owing to the stage of the lake, was about 14 feet. Nevertheless the effect on the bottom seemed to be almost nothing. The material was just about as hard to dig as before, and careful soundings made immediately after a shot failed to reveal even a moderate depression at the point where the charge had rested.

An Ingersoll steam rock drill was then mounted on a scow, and sent to Little Sodus to try the effect of the explosive when fired in drilled holes. Great difficulty was experienced in drilling, owing to the tool very frequently becoming jammed between the hard round bowlders that were thickly embedded in the hardpan. Many delays also occurred from bad weather, for most of the work had to be done outside the shelter of the jetties, and a very moderate sea on the lake was sufficient to stop drilling. However, some 85 holes about 5 feet deep and 8 or 10 feet apart were drilled and fired along the proposed cut. The charged used was about 5 pounds to the hole. The material was undoubtedly loosened somewhat by these shots, but the effect was less than one would have expected—less, certainly, than it would have been in ordinary rock.

On the 17th of November the whole plant was brought back to Oswego and laid up for the winter. During the time it was employed the dredge removed 12,590 cubic yards of sand and 1,777 cubic yards of hard material from the channel.

There was expended in connection with the work at this place for labor and material $5,841.96, and for engineering and office expenses $466.23.

REMARKS.

The completion of the project requires about 665 linear feet of jetty extension and the dredging of some 18,500 cubic yards of hard material. As all the material from the outer end of the jetties to the 15-foot curve in the lake appears to be hardpan, it is reasonable to expect that a cut once dredged through it would remain open, unless it was filled by sand moving out beyond the ends of the jetties from the beach.

There is no evidence that the beach sand is moved out as far as this. Even if the sand does move out and deposit in the cut in moderate quantities, it might be cheaper to maintain the channel by occasional dredging than it would be to keep the increased length of jetties in repair.

It is proper to invite attention to the fact that the United States has constructed some 5,789 linear feet of jetties and breakwaters at this place, of which 4,904 feet is valuable and necessary to the maintenance of the harbor. The rest has been absorbed by the advance of the shore line, and further repairs to it will probably not be required.

Four thousand nine hundred feet of jetty work, in round numbers, therefore, must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below the water is not subject to decay and only needs repairs when it is injured by collisions or storms—accidents of unfrequent occurrence.

But the timber which is above water and which forms the superstructure is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it is liable to give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $11 a running foot. There is now 1,692 feet of it here that is from eleven to sixteen years old. It needs renewal now, and will cost $19,000. This sum is not included in the amount required to complete the existing project.

Name of harbor, Little Sodus Bay, New York. Collection district, Oswego, N. Y.: nearest light-house, Fair Haven, N. Y.; a fixed white light of the fourth order near the head of the west pier, a fog bell attached; a mast range light at the inner end of west pier. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1893, balance unexpended	$6,430.35
June 30, 1894, amount expended during fiscal year	6,308.19
July 1, 1894, balance unexpended	122.16
Amount (estimated) required for completion of existing project	52,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	40,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Little Sodus Harbor, New York, during fiscal year ending June 30, 1894.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	24	2,394	12	2,546	17	5,760
Foreign, on lake	22	1,783	57	8,656	82	22,099
Total	46	4,177	69	11,202	99	27,859
American owned	18	1,295	23	1,845	14	5,179
Canadian owned	28	2,882	46	9,357	85	22,680

Sum total, 214 arrivals; 43,238 registered tonnage.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	20	1,482	4	421	4	1,795
Foreign, on lake	26	2,695	65	10,781	95	26,064
Total	46	4,177	69	11,202	99	27,859

Sum total, 214 departures; 43,238 registered tonnage.

Greatest draft of vessel	feet	12.6
Greatest tonnage of vessel	registered tonnage	679
Greatest load of vessel	net tons coal	1,167

Receipts and shipments by lake at Little Sodus Harbor, New York, during the fiscal year ending June 30, 1894.

Trade.	Receipts.					Shipments.	
	Merchandise.	Fish.	Railroad ties.	Posts.	Lumber.	Merchandise.	Coal.
	Net tons.	*Net tons.*	*Tons.*	*Tons.*	*Tons.*	*Net tons.*	*Net tons.*
Home, on lake	2	¼	....	....	9	2	1,757
Foreign, on lake	....	23¾	2,141	247	....	....	62,165
Total	2	24	2,141	247	9	2	63,922

Navigation closed November 30, 1893; navigation opened April 9, 1894.

For the purpose of reduction to tons weight the following is assumed: Barrels oil, 7 equals 1 ton; M lumber, 1 equals 1¼ tons; crates of fruit, 20 equals 1 ton; railroad ties and poles, 12 equals 1 ton; cords of wood and posts, 1¼ equals 1 ton; live animals, 1 equals 1 ton.

P P 5.

IMPROVEMENT OF HARBOR AT OSWEGO, NEW YORK.

OBJECT.

To provide a basin sufficient for the needs of commerce at the mouth of the Oswego River, New York, on Lake Ontario, and to secure and maintain a navigable channel into said basin and river.

PROJECT.

1827.—To inclose by breakwaters a western basin of 11 acres area outside the bulkhead line, and an eastern basin of 9 acres outside the bulkhead line, and to protect the entrance channel by piers. (Completed 1829; pier extended 1869.)

1870.—To inclose by a breakwater of crib work filled with stone a western basin of 100 acres area outside the 9-feet curve and the existing western breakwater. (Completed in 1882.)

1882.—To build an eastern breakwater on the alignment of the western, sheltering an eastern basin. But little work was done upon this structure, and in 1888 this portion of the project was abandoned and the few cribs that had been sunk were removed.

1883.—To build spurs projecting from lake face of western breakwater for the purpose of breaking the accumulated and reflex waves occasioned by that breakwater, which have rendered the entrance exceptionally difficult and dangerous during storms. (Completed in 1889.)

1891.—To make permanent and to shelter the western entrance to the outer harbor.

1893.—To improve the inner harbor by the removal of rock so as to afford a depth of 15 feet at extreme low water for a distance of several hundred feet up the river.

The following appropriations have been made for this work.

March 20, 1826	$200.00
March 2, 1827	33,348.64
May 19, 1828	9,583.39
March 3, 1829	7,472.00
March 2, 1831	2,812.92
March 2, 1831	18,600.00
March 2, 1831	519.00
March 2, 1831	84.92
February 24, 1832	19,000.00
March 2, 1833	8,400.00
June 28, 1834	30,000.00
July 2, 1836	20,000.00
March 3, 1837	15,000.00
July 7, 1838	46,067.00
June 11, 1844	20,000.00
August 20, 1852	40,000.00
August, 1860, allotment transferred from Light-house	30,000.00
June 28, 1864, allotment	25,000.00
June 23, 1866	45,000.00
March 2, 1867	60,000.00
July 25, 1868, allotment	$20,000.00
April 10, 1869, allotment	22,275.00
April 10, 1869, allotment	6,000.00
July 11, 1870	50,000.00
March 3, 1871	100,000.00
June 10, 1872	100,000.00
March 3, 1873	100,000.00
June 23, 1874	75,000.00
March 3, 1875	90,000.00
August 14, 1876	90,000.00
June 18, 1878	90,000.00
March 3, 1879	90,000.00
June 14, 1880	90,000.00
March 3, 1881	50,000.00
August 2, 1882	80,000.00
July 5, 1884	80,000.00
August 6, 1886	71,250.00
August 10, 1888	100,000.00
September 19, 1890	30,000.00
July 13, 1892	40,000.00
Total	1,805,612.87

PRESENT WORKS.

The present works consist of—

(1) The inner west breakwater, which lies wholly within the outer breakwater, by which it has been superseded.

(2) The inner east breakwater, which has been private property since 1852.

(3) The fort wharf, which constitutes a storage place for harbor material.

(4) The outer west breakwater, whose maintenance constitutes the principal work.

(5) The detached spurs outside the outer breakwater, two of which have been built, and of which two more are proposed to shelter the present western opening.

(6) The deepening of the entrance and river channel in the inner harbor.

These works are described as follows:

(1) *The inner west breakwater.*—This is 1,993 feet long, of masonry and crib work of varying widths, and was built between 1827 and 1837. It is composed of the following parts:

Section A, the shore arm, is 250 feet long, 30 feet wide, and has a crib-work base built in 1828, with superstructure reconstructed of cut limestone masonry, in parapet form, in 1837–'38. In fair preservation.

Section B, from the angle eastward, 110 feet. The same description as the last, except that its condition is ruinous.

Section C, located back of Section B, overlapping it and extending past it a distance of 138.8 feet, including a 10-foot passage for boats cut through its east end in 1884.

This section is of crib work, 22 feet wide, built back of the ruined masonry structure in 1854. Its superstructure was rebuilt on its south or harbor face in 1887, and on its lake face in 1891. It serves to shelter the United States reservation slip, where the United States boats, scows, and dredge are moored, and to provide storage places for timber needed for repairs.

Section D is 838.2 feet long, in prolongation of the line of the masonry portion of the lake arm eastward, and extends to the light-house pier head.

It was built in 1828–'29, and its superstructure was rebuilt and repaired in 1844, 1854, 1860, 1867, 1874, and was burned in the great fire of 1881.

It was transferred to the Light-House Department in 1886 and was rebuilt by the Light-House Department in 1889, in parapet form. The superstructure is built of 12 by 12 inch pine timber, filled with loose stone and decked with 3-inch pine plank. It is 27 feet wide, founded upon the original crib work 30 feet wide. At the west end of this section a small crib-work jetty has just been built in 1892, 12 feet wide and 48 feet long, to shelter the passageway for boats from the outer to the inner harbor. The jetty is formed of a piece of parapet and of old timber from the 1884 breach in the outer breakwater, and its superstructure is of blocks of stone taken from the adjoining lake bottom. A bridge crosses the passageway high enough to permit the passage of the Life-Saving Service boat at extreme high water.

Section E is the light-house pier head of irregular form, extending 92 feet on prolongation of the line of the breakwater and 132 feet at a right angle to it northward. Upon a mass of loose stone, inclosed by the cribs forming the pier-head substructure, stands the masonry light-house which was built in 1836. The cribs were built in 1835, and its superstructure was repaired and rebuilt repeatedly until the transfer to the light-house department in 1886, by which department it was last repaired in 1889.

Section F is 432 feet long in prolongation northward into the lake of the pier head and is 30 feet wide. It is not included in the transfer to the light-house department. It was built in 1869–1871, and is now undergoing thorough repair for the first time.

(2) *The inner east breakwater.*—This is 750 feet long, 30 feet wide, and is located on the prolongation eastward of the line of the inner west breakwater, from whose pier head it is distant 357 feet. The Oswego River flows between them into the lake.

From this point the breakwater extends to the east shore, beneath Fort Ontario. It was built in 1828–'29 in the same manner as the west breakwater. It was repaired in 1844, and 1852 was transferred to Gerrit Smith, esq., whose estate since 1852 has owned and maintained it, building under its shelter wharf property which for many years was very valuable, but which is now not so much used as formerly. In consequence, the breakwater has not been properly maintained for some years past, and it is now in a damaged state.

(3) *The fort wharf.*—This is the landing in the inner harbor for Fort Ontario, and forms a part of the United States reservation pertaining to that fortification. It has been of value in connection with the harbor improvement as a storage place for timber and stone and for framing and launching cribs. It has a water front of about 250 feet, with an area of about 100 feet by 200 feet. The crib work forming its water front was built in 1839, when the fort was built; was repaired in 1863, when the fort was reconstructed, and has recently been repaired above line of no decay for use on the harbor work. It is now in good order.

(4) *Outer west breakwater.*—This is 6,033 feet long, inclosing 100 acres outside the 9-foot curve of what was formerly the open lake front of the city and of the inner harbor. It starts from the lake shore, nearly a mile westward from the river outlet, and extends eastward upon a line generally parallel to the lake front and 1,200 feet from it to a point opposite the entrance to the inner harbor.

The breakwater is formed of timber crib work filled with loose stone and is 35 feet wide throughout.

Its substructure is formed of cribs, each 35 feet long and 35 feet wide, a few of those built last being of double this length. Its superstructure is also timber, and is now in parapet form. Its height on the shore arm is 9⅓ feet above extreme low-water level; on the lake arm, 13⅓ feet.

The original survey for the location of this breakwater was made in September, 1869, the plan was approved by the board of engineers March 30, 1870, and the work of construction was begun on July 5, 1871. It was completed in July, 1882. Its details are as follows, all of the cribs being built upon essentially the same plan as those of the shore arm next described:

The shore arm is 916⅓ feet long, from a ledge of rock forming the shore northeastward into the lake to 18 feet depth at extreme low water.

Section A from the shore 846⅓ feet was built in 1871–'72 of cribs each 35 feet long and wide, sunk in contact with each other upon the natural bottom, the cribs being built to fit the irregular ledges of rock on which most of them were placed. The cribs were formed of 12 by 12 inch hemlock timber, all the sticks being of the same length—35 feet.

The continuous superstructure built the same season upon these cribs was formed of 12 by 12 inch pine timber, 7 courses in height, with horizontal deck 8 feet above extreme low water, of 3-inch pine plank laid crosswise, 3 inches apart, upon 6 by 12 inch pine joists, loose stone of random sizes being filled in to the top of the joists. The planks were fastened by 9 by ½ inch spikes, and by six longitudinal bands of 2 by ½ inch flat iron. Their deck was maintained by annual repairs of varying extent every year from the first until the rebuilding of the superstructure upon a radically different model in 1887. It has required no repairs since.

Section B is 70 feet long in prolongation of the last section to the angle of the lake arm. It was built in 1871-'72, at the same time and in the same manner as the last section. Its superstructure had the same frequent repairs until 1884, when with the following section the superstructure was renewed in parapet form of the 1884 model.

It has received some repairs during the year 1892, and the superstructure on the exposed face needs repairs below water.

Section C of the lake arm is 2,910 feet long from the angle eastward. Points upon the lake arm are described by naming their distances from the angle, measuring along the axis. It was built in 1872-1877 of cribs each 35 feet long and wide, of depths varying from 18 to 30 feet. The cribs were sunk upon the natural bottom of the lake, and about 30 of the first ones settled more or less irregularly into the sand. The bottom upon which the rest stood was of stones and gravel, and very little settlement took place, generally about 1 to 2 feet on the lake surface.

In 1884 the entire superstructure was renewed in parapet form. On December 8, 1884, the waves of an exceptionally severe northwest gale drove 140 feet of the superstructure through into the harbor, with parts of the superstructure down to 9 feet depth, leaving bulkheads at each side of the break.

The opening thus made through the breakwater caused so marked an improvement in the sanitary condition of the inclosed space within the harbor, and was so convenient an entrance for vessels and tugs, that it has not been rebuilt, and will be made a permanent opening. Since the building of the 1884 parapet upon this section of 2,910 feet it has received damage to many points and has had considerable repair, though much less than required by the original flat superstructure.

The part of the breakwater which is in a condition needing close attention, and which may need radical repairs, is that near the 1884 breach. The actual breach was limited, as above described, to 140 feet, and it has not since extended. But the superstructure was strained and its joints opened for 100 feet farther on each side, and it has only been maintained by closely watching it and by putting in screw bolts and steel plates to check indicated yielding. The exposed face of all the cribs of the substructure below water from the angle eastward for about 700 feet (including the 140 feet breach) is more or less shaken, and shows signs of weakness.

Section D is 570 feet long in prolongation of the last section eastward. It was built in 1877-1879 with its cribs placed upon the natural bottom, some being double the usual length, and with continuous superstructure, which was 8 feet high with a flat deck. The superstructure received repairs at various times, and in 1890-'91 it was renewed in parapet form, in connection with the following section.

Section E is 900 feet long, in continuation of the lake arm. Its cribs were built in 1880 and differ from all the preceding ones in that they had a foundation prepared by dredging a trench in the natural sand bottom 3 to 6 feet and 55 feet wide, and then filling it with random stone. Its superstructure was renewed with that of the last section in 1891.

Section F is 490 feet long, in continuation of the lake arm to the eastern angle. The cribs were built in 1880–'82, and founded upon random stone placed in a trench 3 to 10 feet deep and 55 feet wide. The cribs were about 18 feet deep, and the original superstructure was built eight courses high with a flat deck. In 1884 the parapet superstructure was built upon the other, all of white pine, without the creosote in the deck and supports which was used in Section C.

It was damaged by a schooner which was wrecked against the breakwater in 1885, but the shaken timbers held together until 1891, when the injury was repaired in an effective manner by screw-bolting a large steel plate to the face, below water, and filling back of it with grout of clear cement.

This carries the description to the east end of the lake arm, where the channel arm extends southward, inclosing the beacon crib.

Section G, the channel arm, is 246 feet long from the south side of the lake arm, with which it makes about a right angle and extends inward. It was built in 1882, its cribs being placed upon a foundation of random stone, filling a trench dredged 4 to 10 feet in the natural sand bottom, where the depth of water was 20 feet and the sand 15 or more feet deeper.

The superstructure on the first 62 feet next the lake arm had originally a flat deck 6 feet above extreme low water, and the parapet was added in 1882, like that on the preceding section. The inner 184 feet has still the flat deck, but its change to parapet form is part of the project.

Its inner angle was cut into 12 feet below water by a barge in 1891, requiring extensive repairs.

The detached spurs.—Under the project of 1883 two or more detached spurs outside of the outer breakwater were provided for. Of these two have been built; one, situated 250 feet west of the eastern end of the breakwater, was built in 1885; the other, situated midway of the length of breakwater, was built in 1889. The first one consists of a single crib 100 feet long, 40 feet wide, and 25 feet deep, with 4-inch close floors 4 feet above the bottom and with vertical sides to mean water level. It is placed with its long axis at a right angle to the face of the breakwater, and is separated from the latter by a space of 10 feet.

The natural bottom at the place was of sand 15 or more feet deep, and a trench was dug for each side and each end of the crib 10 feet deep and 15 feet wide at bottom, and this trench was filled with random stone.

The riprap base thus formed extended 10 feet outside of the crib line all around. It was leveled at 21 feet below extreme low water, and the crib sunk upon it. It was undermined by the wave action along the west face, and in 1888 the west side had settled to 7 or 8 feet lower than the east side. It now stands in this position. Large amounts of dredge material, stone, gravel, etc., have been deposited along the west side, filling it up to 10 feet depth, and the structure appears secure from further settlement. It has not since been repaired.

The second detached spur, built in 1889, was located 2,600 feet westward of the eastern end of the breakwater, about midway of its length. It also is placed with its long axis at a right angle to the breakwater face from which a 10-foot space separates it. Its length is 150 feet, with a bottom width of 40 feet, a surface width of 26½ feet, and a top width of 14 feet.

The sides slope regularly from 5 feet above the bottom to the top of the superstructure. It has not since been repaired.

It now needs some additional stone filling, as a recent examination shows that the upper portion is empty, probably due to settlement of its filling.

HARBOR DREDGING AND RIVER CHANNEL.

1847.—The first dredging of which there is record was done in 1847, when a gravel bar which had formed across the river channel, apparently about 1,000 feet inside the breakwater, was removed at private expense.

1855.—The next was in 1855, when the United States dredge, under direction of the engineer in charge, was engaged in deepening the entrance to the river near the head of the upper island at the expense of the city.

1861.—This dredge was sold in 1861, for lack of funds to maintain it. No other dredging is reported up to this date and it is not likely that any had been done, as the harbor and its entrance had a general depth in excess of the draft of the lake vessels.

1866–'69.—In 1866 the inner harbor adjoining the west breakwater was too shoal to accommodate the increased draft of vessels to 12 feet, and its dredging was commenced. The quantity and price of excavation is not stated, but $29,451 was thus expended to June 30, 1867, when about $12,000 was estimated as the cost of completing it. The work was continued and finished in 1868 and 1869, 12 feet depth at extreme low-water level being reported in the west inner harbor.

1881.—No further dredging was done until June, 1881, when work under contract was begun for deepening the river channel from the entrance near the light-house to the head of the island at the foot of Schuyler street, for a length of 1,426 feet and a width of 125 feet. This deepened to 15 feet below extreme low-water level the west half of the river channel, outward from the south line of Schuyler street, excepting a small area next the upper island wharf, where bed rock prevented dredging below 12 feet. Twenty-three thousand one hundred and ninety-two cubic yards, at 70 cents per yard in scows, were removed in 1881. The material taken out was gravel and stones, with many large pieces of bed rock, brought down by ice from the river bed in the rapids above the city, the thickness of the layer worked upon by the dredge varying from 1 to 6 feet. Before beginning work many borings were made in the area to be worked upon, to determine whether the channel could be made. Bed rock, with 12 feet depth, was found beneath the loose deposit, extending out 50 feet into the channel from the east and west island wharves, just north of Schuyler street. No attempt was made to remove this.

1883–'84.—In September, 1883, dredging was resumed to deepen the east half of the channel. This was done at 30 cents per cubic yard in scows, and was completed in July, 1884; 34,123 cubic yards were removed. The material consisted of gravel, stone, and rock, and was dumped upon the prolongation eastward of the line of the east breakwater to serve as a foundation for the proposed eastern extension of that work. The depth which was made increased from 15 feet at the upper end to 17 feet at the lower end to allow for rise and fall of waves.

1883.—In 1883, without cost to the United States, there was also dredged from the inner west harbor 5,000 cubic yards of gravel for wharf filling.

1887.—Up to this time the draft of vessels had been limited to 12 feet by the depth that could pass the Welland Canal, but in 1887 this was increased to 14 feet, and the inner harbor, above the limit of the dredging of 1884, was too shallow, except at a high stage of the lake.

1890.—During 1890 and 1891 rock excavation to 16 feet depth was done at private cost to extend the channel above described up to the Marine elevator (the most northern one on the east side) and to the

New York, Ontario and Western Railroad coal trestle on the upper east island wharf. This at once increased the available depth of the harbor to 16 feet, and large steamers came to use it before the work was fully complete.

1891.—In 1891 the clearing off of loose material from the bed rock was continued by the United States up to the north line of Cayuga street, a farther distance of 900 feet for 240 feet width, leaving undredged 100 feet next the wharves on each side. Over this area the effective depth was increased 2 or 3 feet, the rock shoaling from 15 feet at the north end of the work to 7½ feet at the south end. Sixteen thousand eight hundred and forty-five cubic yards were removed at 23½ cents in scows. In addition there were many pieces of ledge rock which the dredge could not raise which were taken out by the United States hired labor with a derrick boat. The aggregate was about 78 cubic yards, costing an average of $7.58 per yard. After completing this the ridges of gravel and stones were leveled off by dragging a bar of railroad iron over the bottom.

1892.—In 1892 the United States dredge was employed to remove a ridge of sand 20 to 50 feet wide which had formed in the outer harbor along the harbor face of the outer breakwater by the material washed over and through it. This work began at Station 3075, and extended thence westward to Station 1400. The deposit had reduced the original depth of about 17 feet to 10 or 12 feet, and its removal required the dredging of 10,010 cubic yards, including 385 cubic yards of stone crib filling, which was saved. The dredge also reopened in 1892 the boat passage which was originally dredged through the inner old breakwater to the outer harbor in 1884.

1893.—The act of Congress approved March 3, 1893, authorized the unexpended balance of the current appropriation to be applied to the removal of rock within the harbor lines to a uniform depth; and in pursuance thereof 3,170 cubic yards of solid rock, measured in place, was drilled, blasted, and removed, at a cost of $8,957.50. During the same season a dredging plant was hired for 131½ hours to remove a shoal near the light-house at the entrance to the inner harbor, 2,806 cubic yards of gravel and loose stone were removed at a total cost of $986.25.

OPERATIONS.

The project approved April 14, 1893, for the removal of about 3,000 cubic yards of solid rock from the inner harbor near the river mouth was in process of execution at the beginning of the fiscal year. The object of this improvement was to secure in this portion of the harbor a uniform depth of not less than 15 feet at low water, which would enable vessels of this draft to reach certain grain elevators and coal trestles at any stage of the lake.

The firm of Hingston, Rogers & O'Brien, of Buffalo, N. Y., were hired to do this work. They were paid $2.75 a cubic yard, measured in place, for all rock removed from within the given area. No payment was made for rock which it was necessary to remove below the 15-foot plane in order to secure the required depth throughout, nor for any loose material that was lying on top of the solid rock. The work was begun by the contractor on May 4, 1893, and completed in the following September; 3,170 cubic yards of solid rock were removed by drilling, blasting, and dredging. The cost of this work was $8,957.50, exclusive of engineering and office expenses, of which sum $5,730 were expended during the present fiscal year.

The result of this work was to extend the deep water about 300 feet up the river. It ought to be extended farther, but even as it is the effect has been very beneficial to the commerce of Oswego. Notwithstanding the general business depression, the shipment of anthracite coal from this port during the past year has been larger than ever before, and the increase, I am informed, has been mainly from the trestles benefited by this improvement. It is an interesting fact that the shipment of coal during the last month of the fiscal year was greater than that of any previous month in the history of the port, and the shipment on the last day of the year, which was over 10,000 net tons, was greater than that on any previous day.

It is also worthy of note that, as another result of this improvement, several cargoes of wheat have been received here direct from Duluth for through shipment to New York, being the first "through wheat," as I am informed by shippers, that has come here for more than ten years. I am also informed that wheat is now being carried from Duluth to New York by lake and canal via Oswego for 4½ cents a bushel, a rate which certainly must enable this route to command a fair share of the business.

By authority of the Chief of Engineers, the dredging plant belonging to Edward J. Hingston was hired at the rate of $7.50 an hour to remove a shoal near the light-house at the entrance to the inner harbor, which shoal was proving an obstruction to navigation. Work was begun on the 31st of August and completed on the 19th of September; 131½ working hours were required to accomplish the desired result; 2,806 cubic yards of gravel and loose rock were removed, which gave a depth of channel of 17 feet at low water. This dredging developed the fact that the work done here under contract in 1883 had not secured a depth of 17 feet throughout the channel, as was generally supposed; for bed rock was discovered in certain places near the edge of the channel at a depth of 13 feet, and this rock, of course, never could have been removed. No attempt was made to remove it at the present time, for there is sufficient width of channel having the required depth for the present requirements of commerce. The cost of removing the shoal was $986.25.

Repair of breakwater.—A bad place was discovered in the outer breakwater at a point just west of the second spur crib. The 35-foot crib that formed substructure at this place was in a very bad condition. Several sticks of timber had been torn away from the lake face of the crib, forming an opening about 5 feet high and 20 feet long at and below the water line. Through this opening a large amount of stone filling had escaped, completely emptying two pockets of the superstructure, and partly emptying a third.

To repair this break, two large blocks of concrete, each about 8 feet by 10 feet, by 14 feet high, were constructed to fill the pockets. The concrete was mixed on the top of the parapet, and was deposited in suitable molds, made of 4-inch plank. These molds were suspended over the pockets, and were gradually lowered with jackscrews as the concrete was built up. So the upper surface of the concrete was always kept above water. The finished blocks weighed about 90 tons each. These two blocks are still in place, though they have settled down, due to the stone filling escaping from beneath them, some 4 or 5 feet. Three attempts were made to place a similar block in the partly emptied pocket, but each time the block was utterly destroyed by a storm before it had time to set. Owing to the lateness of the season and the extreme cold weather work was necessarily suspended.

In the meantime the condition of the foundation crib has become worse and worse. Several more courses of timber have broken away from it on the lake face, and the hole in it is now 35 feet long, the full length of the crib, and much more stone has gone out of it.

The superstructure, which is now a mere shell at this point, spans the opening like a bridge. It has only been prevented from being breached by the waves by the inertia of the massive concrete blocks before described. As soon as these blocks settle a little lower they will no longer afford any support to the superstructure, which will then doubtless be broken through by the first heavy storm, and a complete breach will be formed in the breakwater. It is a marvel to me that this has not occurred already.

Complete and thorough repairs will be required at this place. The wreck of the submerged crib will have to be entirely dredged up, and a new crib built and sunk in its place. Upon this a new superstructure will have to be built and bonded into the superstructure on each side of the break. These repairs will cost $10,000. The necessity for this expenditure was not foreseen at the time of making my last annual report. But the matter has been brought to the notice of the Committee on Rivers and Harbors at a special hearing that they accorded me in April, 1894.

In addition to these repairs made or attempted to be made, as before described, minor repairs have been made to the breakwater from time to time as they were required; broken plank were replaced and stone filling added when needed. The total amount expended for repairs was $1,984.66.

The plant belonging to the work has been cared for and repaired as required. The timber on hand, which began to show some signs of the discoloration which precedes decay, was all repiled this spring. In order that the upper line of the rock excavation in the inner harbor might be plainly visible to the pilots of vessels, I caused it to be marked by two large wooden spar buoys.

The amount expended for care and repair of plant, etc., is $1,699.23, and for all engineering and office expenses, $2,895.40.

REMARKS.

The removal of what had been built of the east breakwater, thus abandoning that portion of the project which called for an eastern basin, leaves the whole in a rather unsatisfactory condition.

The entrance to the western basin, which would have been sheltered by the east breakwater, is now exposed to the full force of the northeast gales, and at the same time it is almost impossible for a sailing vessel, unaided by steam, to enter the west basin at all when driven by a strong wind from the northwest.

I am of the opinion that the east breakwater will have to be built either as originally proposed or else in some modified form before the harbor will be entirely safe and satisfactory.

The present project permits the break, 140 feet long in the outer breakwater near the shore arm, to be left open, and proposes the construction of two properly located spur cribs to protect the entrance. The cribs adjacent to the break are considerably shaken and need extensive repairs, and the spur cribs should be built as soon as possible.

The whole work will cost about $75,000.

It is proper to invite attention to the fact that the United States has constructed some 8,776 linear feet of piers and breakwaters at this place, of which 6,465 feet is valuable and necessary to the maintenance of the harbor. The rest has been superseded by the construction of new breakwater, or disposed of to other departments of the Government or to private individuals, and further repairs to it will probably not be required. Six thousand eight hundred feet of pier work, in round numbers, therefore, must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below water is not subject to decay, and only needs repairs when it is impaired by collisions or storms, accidents of unfrequent occurrence. But the timber, which is above water and which forms the superstructure, is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it is liable to give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $40 a running foot. There is now 3,716 feet of it here that is from eleven to sixteen years old. It needs renewal now and will cost $150,000. This sum is not included in the amount required to complete the existing project.

Name of harbor, Oswego, N. Y.; collection district, Oswego, N. Y.; nearest lighthouse, Oswego, N. Y.; a fixed white light of the third order at the eastern end of the old west breakwater; a fixed red light of the fourth order on the eastern end of the outer west breakwater; a fog bell attached. Nearest works of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1893, balance unexpended	$18,818.12
June 30, 1894, amount expended during fiscal year	13,295.54
July 1, 1894, balance unexpended	5,522.58
July 1, 1894, outstanding liabilities	120.12
July 1, 1894, balance available	5,402.46
Amount (estimated) required for completion of existing project	85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	85,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Oswego Harbor, New York, for fiscal year ending June 30, 1894.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.			
					On lake.		On river.	
	No.	Registered tonnage.	No.	Registered tonnage.	No.	Registered tonnage.	No.	Registered tonnage.
Home, on lake	337	86,980	209	25,619	114	25,908	......	....
Home, on river	102	11,118	......	....	......	....	590	82,600
Foreign, on lake	413	93,727	620	125,366	391	103,215	......	....
Total	852	191,825	829	150,985	505	129,123	590	82,600
American owned	573	138,016	258	49,763	224	46,434	590	82,600
Canadian owned	279	53,809	569	101,222	281	82,689	......	....

Sum total, 2,776 arrivals; 554,533 registered tonnage.
Arrivals, 1892, 2,791; tonnage, 516,960. Arrivals, 1893, 2,697; tonnage, 543,023.

Oswego Harbor, New York, for fiscal year ending June 30, 1894—Continued.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.			
					On lake.		On river.	
	No.	Registered tonnage.	No.	Registered tonnage.	No.	Registered tonnage.	No.	Registered tonnage.
Home, on lake	407	119,837	235	38,843	72	17,819	......	....
Home, on river	102	11,118	......	....	......	....	590	82,600
Foreign, on lake	341	56,701	585	110,519	391	107,655	......	....
Total	850	187,656	820	149,362	463	125,474	590	82,600

Sum total, 2,723 departures; 545,092 registered tonnage.

Greatest draft of vessel ....feet.. 15.4
Greatest tonnage of vessel....................registered tonnage.. 1,319
Greatest load of vessel..net tons.. 1,798

Receipts and shipments by lake and river at Oswego, N. Y., for the fiscal year ending June 30, 1894.

Trade.	Receipts.							Shipments.					
	Passengers.	Grain.	Coal.	Merchandise.	Fish.	Oil.	Lumber, etc.	Passengers.	Grain	Coal.	Merchandise.	Oil.	Lumber.
		Net tons.	*Net tons.*	*Net tons.*	*Net tons.*	*Net tons.*	*Tons.*		*Net tons.*	*Net tons.*	*Net tons.*	*Net tons.*	*Tons.*
Home, on lake	1,272	37,595	......	2,442	69	......	4,559	2,024	......	227,093	1,689	56	16,500
Home, on river	......	1,746	10,479	11,780	......	5	328	......	15,903	5,180	8,404	......	44,688
Foreign, on lake	1,419	5,507	......	982	156	......	161,530	1,013	308	388,317	2,350	32	......
Total	2,691	44,848	10,479	15,204	215	5	166,417	3,037	16,211	620,590	12,443	88	61,188

Navigation closed December 8, 1893; navigation opened March 30, 1894.

For the purpose of reduction to tons' weight the following is assumed: Barrels oil, 7 equal 1 ton; 1,000 feet lumber equal 1½ tons; crates fruit, 20 equal 1 ton; railroad ties and poles, 12 equal 1 ton; cords wood and posts, 1 equals 1½ tons; live animals, 4 equal 1 ton.

P P 6.

IMPROVEMENT OF HARBOR AT SACKETTS HARBOR, NEW YORK.

OBJECT.

To deepen the natural harbor formed by Ship House Point over an area of about 15 acres to 12 feet at extreme low water. This project was adopted in 1881. Previous to this, in 1826–'28, $6,000 had been expended for the same purpose.

PRESENT PROJECT.

To limit the excavation to an area of about 6 acres and to define the entrance and provide a mooring place by building a crib 18 feet square upon the point of the shoal extending into the harbor from the end of Ship House Point.

Also to check shore drift by extending a jetty across the end of Ship House Point from the crib above described to the bay outside the point.

The following appropriations have been made for this work:

May 20, 1826	$3,000
May 23, 1828	3,000
August 2, 1882	7,000
August 11, 1888	2,000
Total	15,000

PRESENT WORKS.

A crib 18 feet square has been built, as proposed in the project; a jetty of stake and fascine work, loaded with stone, has been completed for a distance of 164 feet, and about 24,000 cubic yards of material have been dredged from the sheltered area, giving a depth of 12 feet at extreme low water.

OPERATIONS.

None other than the collection and reporting of commercial statistics.

REMARKS.

This harbor is formed by a natural spur of loose rock and gravel, about 800 feet in length, extending in an easterly direction from the shore, so as to form a small sheltered bay, and the value of the harbor depends upon the preservation of this natural spur or breakwater.

During the war of 1812 the United States began the construction of a large naval vessel upon this spur. The vessel was never launched, work on it having been stopped by the treaty of peace; but the vessel was cared for for a great many years, and incidentally the site on which it stood was prevented from washing away, due to wave action. A few years ago the vessel was sold and broken up, and since then this spur has not been cared for, and consequently is slowly being destroyed by the seas. It is not, however, exposed to very heavy waves, and can be protected by a rough wall of blocks of stone of one or more tons in weight built parallel to it and from 50 to 100 feet in advance of it, where the water is about 6 feet deep. This stone can be advantageously obtained from quarries in the neighborhood, and it is estimated that it can be put in for about $3 a cubic yard. Five thousand dollars could be advantageously applied to this purpose and would be sufficient to complete the proposed wall. No more dredging seems to be necessary at present.

Name of harbor, Sacketts Harbor, N. Y.; collection district, Cape Vincent, N. Y.; nearest light-house, Sacketts Harbor, N. Y.; a fixed white light of the fifth order on Horse Island, 1¼ miles west of town; nearest works of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1893, balance unexpended	$411.26
June 30, 1894, amount expended during fiscal year	93.52
July 1, 1894, balance unexpended	317.74
Amount (estimated) required for completion of existing project	5,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	5,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Sacketts Harbor, N. Y., during fiscal year ending June 30, 1894.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.	
	Number.	Registered tonnage.	Number.	Registered tonnage.
Home on lake	36	1,760	86	2,772
Foreign on lake	5	461	4	448
Total	41	2,221	90	3,220
American owned	36	1,714	86	2,772
Canadian owned	5	507	4	448

Sum total, 131 arrivals; 5,441 registered tonnage.

DEPARTURES.

Home on lake	37	1,911	87	2,888
Foreign on lake	4	310	3	332
Total	41	2,221	90	3,220

Sum total, 131 departures; 5,441 registered tonnage.

Greatest draft	feet..	10
Greatest tonnage	registered tonnage..	197
Greatest load	net tons..	224

Receipts and shipments by lake at Sacketts Harbor, N. Y., during fiscal year ending June 30, 1894.

Trade.	Receipts.						Shipments.	
	Passengers.	Posts and wood.	Merchandise.	Hay.	Coal.	Lumber.	Passengers.	Merchandise.
		Net tons.	*Net tons.*	*Net tons.*	*Net tons.*	*Tons.*		*Net tons*
Home on lake	....	....	809	1,853	3,711	425	686	30
Foreign on lake	....	....	432	....	....	....	235	111
Total	....	....	1,241	1,853	3,711	425	921	141

Navigation closed, December 1, 1893; navigation opened, March 28, 1894.

For the purpose of reduction to tons weight the following is assumed: Barrels oil, 7 equal 1 ton; M lumber, 1 equals 1½ tons; crates fruit, 20 equal 1 ton; railroad ties and poles, 12 equal 1 ton; cords wood and posts, 1 equals 1½ tons; live animals, 4 equal 1 ton.

APPENDIX Q Q.

IMPROVEMENT OF RIVERS AND HARBORS IN VERMONT AND NORTHERN NEW YORK.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Shoals between Sister Islands and Cross-over Light, St. Lawrence River, New York.
2. Ogdensburg Harbor, New York.
3. Breakwater at Rouse Point, Lake Champlain, New York.
4. Great Chazy River, New York.
5. Plattsburg Harbor, New York.
6. Burlington Harbor, Vermont.
7. Otter Creek, Vermont.
8. Ticonderoga River, New York.
9. Narrows of Lake Champlain, New York and Vermont.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., July 1, 1894.

GENERAL: I have the honor to transmit herewith annual reports for the river and harbor works under my charge during the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

SMITH S. LEACH,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 1.

IMPROVEMENT OF SHOALS BETWEEN SISTER ISLANDS AND CROSS-OVER LIGHT, ST. LAWRENCE RIVER, NEW YORK.

The project for this improvement resulted from a survey and report made in compliance with a provision in the river and harbor act of August 11, 1888, directing a survey of the shoals between Sister Islands and Cross-over Light to be made. The report was submitted July 2, 1889, and printed in the Report of the Chief of Engineers, 1889, pp. 2463 and 2464.

The estimate, as below, provided for the removal to a depth of 18 feet at low water of three shoals, the first or lower one situated a little above the entrance to Blind Bay; the second, or middle one, near Dark Island; the third, or upper one, about 1½ miles above Dark Island, the distance between the lower and upper shoal being about 4 miles.

ESTIMATE.

Removing 162 cubic yards of rock, lower shoal, at $20 per cubic yard	$3,240
Removing 1,830 cubic yards of rock, middle shoal, at $18 per cubic yard	32,940
Removing 85 cubic yards of rock, upper shoal, at $25 per cubic yard	2,125
Contingencies	5,000
Aggregate	43,305

The discovery of three outlying spurs of the upper or "Haskell" Shoal, the removal of which was necessary to free the locality from dangerous obstructions, called for a revised estimate, which was submitted in the last annual report as follows:

REVISED ESTIMATE, 1893.

Removing 2,627 cubic yards of rock, at $20.85	$54,772

Appropriations of $5,000 in the act of September 19, 1890, and $10,000 in the act of July 13, 1892, have been expended under contract and have resulted in the removal of the upper and lower shoals, leaving the middle or Dark Island Shoal, estimated to require $32,940, yet to be removed.

At the beginning of the present fiscal year the first appropriation and about $3,000 of the second had been expended, and a contract was pending with Willard Johnson, of Fulton, N. Y., for the removal of 235 cubic yards from the upper shoal, at $10.75 per cubic yard. This contract was satisfactorily executed during the month of September, 1893. The actual quantity of rock taken out was 277 yards and the cost, including inspection and other necessary charges against the appropriation during the year, was $3,524.51, leaving a balance now available of $3,186.50.

Money statement.

July 1, 1893, balance unexpended	$6,711.01
June 30, 1894, amount expended during fiscal year	3,524.51
July 1, 1894, balance unexpended	3,186.50
Amount (estimated) required for completion of existing project	39,772.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	39,772.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Nearly the entire commerce of the St. Lawrence River passes over or near these shoals. The nearest light-house, Cross-over Light. Greatest draft of vessels, 16 feet.

Amount of commerce which passed over the shoals of the St. Lawrence River between Sister Islands and Cross-over Light during the calendar year 1893.

	Tons.
Entered and cleared at Ogdensburg from and to points west (see reports for Ogdensburg Harbor)	925,364
Passed through Cardinal canals and down Galops Rapids (from data courteously furnished by John H. Balderson, secretary department of railways and canals, Ottawa	754,563
Total tonnage passing the section of river under improvement in 1893	1,679,927

Q Q 2.

IMPROVEMENT OF OGDENSBURG HARBOR, NEW YORK.

The object of this improvement has been the formation of a channel along the wharf frontage of the port of Ogdensburg of adequate width and depth, with entrances connecting this channel with deep water in the St. Lawrence River. The work has been carried on under three successive projects, adopted in 1868, 1882, and 1890. These projects have covered substantially the same areas, but have provided for a progressive deepening from the original depths of 5 to 12 feet to proposed depths of 12, 15, and 16½ feet respectively.

The project of 1890 was adopted while that of 1882 was still incomplete, and was estimated to cost $158,950. The act of 1890 appropriated $42,000, which was expended under contract in part execution of the project. After extension, at contractor's cost, work was completed on June 8, 1893, giving a channel of the proposed depth and 150 feet in width from the lower end of the harbor nearly to the lower side of the Oswegatchie River, with two entrances from the St. Lawrence.

The appropropriation in the act of 1892, $40,000, has been expended under contract, and has resulted in the extension of the 150-foot channel to and across the mouth of the Oswegatchie River, with narrow cuts extending along the sides of that stream, to reach the coal wharves and the grain elevator, to both of which full cargoes can now be carried. Further appropriations for this project will be expended in widening the channels already made, which are too narrow for convenient use. If the commerce of the port does not demand greater depth in the near future, the amount of the present estimate will give all needed relief.

Money statement.

July 1, 1893, balance unexpended	$44, 694. 01
June 30, 1894, amount expended during fiscal year	43, 746. 91
July 1, 1894, balance unexpended	947. 10
Amount (estimated) required for completion of existing project	76, 950. 00
Amount that can be profitably expended in fiscal year ending June 30, 1896	76, 950. 00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Name of harbor, Ogdensburg, N. Y.; collection district, Oswegatchie; nearest light-house, Ogdensburg, N. Y.

Tonnage of vessels entered and cleared, foreign ports and coastwise, 1893.

	East of Ogdensburg.				West of Ogdensburg.			
	American vessels.		Foreign vessels.		American vessels.		Foreign vessels.	
	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Foreign ports	9, 833	5, 337	29, 080	22, 606	30, 000	10, 000	70, 001	70, 060
Coastwise	3, 500	3, 600	....	....	358, 350	386, 953	....	....

Merchandise received and shipped, foreign ports.

Articles.	Tons.
Received:	
Lumber	114,562
Barley, etc	11,562
Hay	3,000
Miscellaneous freight	1,600
Shipped:	
Coal	77,543
Cheese	2,580
Oil	3,912
Miscellaneous freight	18,345
Wheat, rye, oats, and corn	71,049
Sugar	2,803
Total	306,956

Merchandise received and shipped, coastwise.

Articles.	Tons.
Received:	
Lumber	70,085
Grain	231,140
Flour	26,860
Coal	161,709
Miscellaneous freight	1,930
Bran	51,383
Shipped:	
Miscellaneous freight	57,985
Total	601,092

Total duties collected	$140,098.11
Total fees collected	2,678.10
Value of imports	2,126,535.00
Value of exports	4,022,838.00
Value of merchandise entered for warehouse and transshipped in bond	45,418.00
Value of merchandise entered for transshipment and export	340,566.00
Amount of duties on the above	148,348.91

Merchandise received under consular seal from foreign ports, 1893.

Articles.	Packages.	Value.
Tea	87,926	$781,492.69
Curios	3,002	105,109.94
Raw silk	3,442	1,484,124.65
Silk goods	1,031	605,724.87
Straw braid	5,488	78,597.32
Chinese groceries	2,331	21,336.84
Confectioneries	426	16,577.07
Copper matte … pounds	15,311,922	636,419.93
Skins	74	24,733.65
Miscellaneous articles	1,350	39,745.88
Rice	1,120	4,908.30
Total		3,798,801.04
Estimated duties on above		443,955.62

Q Q 3.

BREAKWATER AT ROUSE POINT, LAKE CHAMPLAIN, NEW YORK.

The project for this improvement was adopted in 1885, and contemplated the construction of a straight breakwater extending from Stony Point in a southeasterly direction to the 18-foot curve in the lake, a distance of about 2,000 feet, at an estimated cost of $110,000, or $55 a linear foot. The all-stone type of structure was adopted, consisting of a rubble foundation and a superstructure or parapet of rubble, faced with large stones, laid with moderately close joints and in fairly true lines and surfaces.

Under appropriations of 1885, 1886, 1888, and 1890, aggregating $83,500, contracts were made and executed resulting in the completion of 1,700 feet of the breakwater. It was then found that the 18-foot curve was 125 feet from the unfinished end, and it was decided to close the work with an extension of 135 feet. The act of 1892 appropriated $15,000 for making such extension, which was placed under contract.

Work was begun in the fall of 1892, resumed on the opening of navigation in 1893, and completed in October, 1893. The breakwater is now completed, at a cost per foot slightly less than the estimate and at a total cost, owing to reduced length, of $98,434.29, against $110,000 estimated.

Money statement.

July 1, 1893, balance unexpended	$10,269.11
June 30, 1894, amount expended during fiscal year	10,203.40
July 1, 1894, balance unexpended	65.71

COMMERCIAL STATISTICS.

Name of harbor, Rouse Point, N. Y. Collection district, Champlain. Nearest light-house, Windmill Point.

Vessels entered and cleared, 1893.

	Number.	Tonnage.
Entered	826	75,408
Cleared	694	56,815

Duties collected	$292,925.14
Duties assessed on merchandise entered for warehouse and transportation to other ports	115,809.92
Tonnage tax collected	2,362.64
Fees collected	7,878.27
Miscellaneous collections	4,712.06
Total collected and assessed	423,688.03

Number of tons shipped and arrived, Rouse Point, N. Y., 1893.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Boards, deals, plank, etc	95,142	105,478
Other lumber	31,718	33,744
Coal	85,000	87,180
Miscellaneous articles	52,042	53,764
Total	263,902	280,166

Q Q 4.

IMPROVEMENT OF GREAT CHAZY RIVER, NEW YORK.

The project for this improvement, adopted in 1889, was based on a survey made in accordance with the river and harbor act of 1888. It was proposed to dredge a channel 40 feet wide and 5 feet deep at low water from the 5-foot curve in the lake to Champlain village, a distance of 5½ miles, at an estimated cost of $18,000.

An appropriation of $10,000 in the act of 1890 was expended by contract, in part execution of this project, and to secure the greatest benefit from the work done, it was determined to make a single cut over the entire length. This was nearly accomplished. The dredging, beginning at the lake, had reached the lower part of the village, when the funds were exhausted, giving for the length worked over a channel something more than half the proposed width and of the full depth.

The appropriation of $5,000 in the act of 1892 has been expended under contract in widening the channel at some points, and in extending the single cut to within 500 feet of the bridge, which limits the project. The contractor did not complete the work on time, and the contract was extended, at his cost, to June 30, 1894. The work was completed during the months of May and June. The balance due under the estimate, $3,000, will suffice to complete the project.

Money statement.

July 1, 1893, balance unexpended	$4,969.83
June 30, 1894, amount expended during fiscal year	4,630.48
July 1, 1894, balance unexpended	339.35
Amount (estimated) required for completion of existing project	3,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	3,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Name, Great Chazy River, New York. Collection district, Champlain. Nearest light-house, Isle La Motte.

Vessels arrived and departed, 1893.

Character of craft.	Arrived.		Departed.	
	No.	*Tons.*	*No.*	*Tons.*
Steam vessels	94	218	94	218
Canal boats	21	1,615	24	1,900

Cargoes:

Value of arrivals	$9,295
Value of departures	960

Number of tons arrived and shipped, 1893.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Iron	....	100
Coal	....	1,485
General merchandise	300	310

Q Q 5.

IMPROVEMENT OF PLATTSBURG HARBOR, NEW YORK.

The original project for the improvement of this harbor was adopted probably in 1836, the date of the first appropriation, and proposed the construction of a breakwater about 1,000 feet east of the steamboat docks.

There were 1,250 linear feet of breakwater constructed between the years 1836 and 1875.

The modification of 1870 provided for an extension of the former structure southeastward, the dredging of some shoal areas within the breakwater, and the protection of a portion of the adjacent beach by a revetment.

Operations were confined to necessary repairs and the dredging of limited areas near the steamboat docks after the completion of the project of 1870 until the act of September 19, 1890, made provision for a northward extension to the breakwater 300 feet, and for replacing by a stone parapet the crib superstructure of the older part.

Under the appropriation of $32,500 in the act of 1890 this final project was completed, operations having been closed, as stated in the last annual report, on January 17, 1893:

Money statement.

July 1, 1893, balance unexpended	$267.97
July 1, 1894, balance unexpended	267.97

COMMERCIAL STATISTICS.

Name of harbor, Plattsburg, N. Y. Collection district, Champlain. Nearest lighthouse, Cumberland Head; two beacon lights on the Plattsburg breakwater.

Arrival and departure of vessels, 1893.

Character of craft.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Steam vessels	934	541,786	934	541,786
Sail vessels	59	5,327	59	5,327
Canal boats	812	69,585	812	69,585
Total	1,805	616,698	1,805	616,698

Value of goods shipped	$289,416
Value of goods arrived	105,710

Number of tons arrived and shipped, Plattsburg Harbor, New York, 1893.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Iron ore	11,840	
Potatoes	4,675	
Coal		17,170
Lumber	7,480	6,500
General merchandise	1,850	13,755
Iron	800	

Vessels enrolled at Plattsburg Harbor, New York, December 31, 1893.

Number	330
Gross tonnage	33,428.73
Net tonnage	31,374.05

Q Q 6.

IMPROVEMENT OF BURLINGTON HARBOR, VERMONT.

The first project for the improvement of this harbor was probably adopted in 1836. Modifications of the original project have been made from time to time so as to afford adequate protection to the increasing commercial and shipping interests of the harbor.

In 1874 an extension 2,000 linear feet northward was proposed and carried out; in 1884 the officer then in charge proposed an extension to the southward; and again, in 1886, a plan for further extension at both ends of the breakwater was considered by the Board of Engineers and received its authoritative sanction in regard to distance from shore. A 200-foot opening recommended at the north end of the existing structure in prolonging the breakwater in that direction also received approval.

It is now proposed to gradually withdraw the ends of the breakwater, in prolonging it, from water 36 and 39 feet deep into water about 30 feet deep, and then to keep at a distance of about 1,000 feet from the docks in constructing new work, so as to reduce the cost.

The construction of 360 feet northward extension to the breakwater, with stone superstructure, fully described in the annual report for 1892 for this district, was the last new work at this harbor.

The older parts of the timber superstructure are now much decayed, and in view of the success which has attended the application of stone parapets on subaqueous cribs, it does not seem profitable to attempt any repairs, except by replacement of the timber by stone. The systematic renewal of the superstructure on this plan should begin at once, in order to keep pace, with reasonable appropriations, with the progressive decay of the parts built in successive years. A length of 1,000 feet at the south end should be first undertaken, to accomplish which an appropriation of $10,000 is asked, to be used in conjunction with the balance now on hand.

Money statement.

July 1, 1893, balance unexpended	$15,691.83
June 30, 1894, amount expended during fiscal year	126.18
July 1, 1894, balance unexpended	15,565.65
Amount (estimated) required for completion of existing project	129,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Name of harbor, Burlington, Vt. Nearest light-house, Juniper Island. Collection district, Vermont; two beacon lights on the Burlington breakwater.

Arrivals and departures of vessels, 1893.

	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
From and to lake ports	1,859	565,745	1,880	568,473
From and to Canadian ports	111	14,219	81	11,008
Total	1,970	579,964	1,961	579,481

Merchandise received and shipped.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
RECEIVED.			RECEIVED—continued.		
Lumber ....feet..	19,906,959	$191,238	Oats ....bushels..	500	$175
Pickets ....pieces..	2,472,455	14,468	Apples ....barrels..	675	1,300
Laths..................do...	3,212,400	4,925	Fire wood ....cords..	150	500
Shingles...............do...	1,851,000	2,977	Furniture, unfinished	....	1,125
Railroad ties..............	2,400	300	Timber, hard pine ..feet..	150,000	4,500
Iron pipe............tons..	240	15,600	Coal ....tons..	56,500	220,000
Pig iron ....do...	245	4,900	General merchandise.do...	11,500	1,000,000
Molding sand .... do...	500	2,000			
Stone...................do...	3,900	1,560	Total....................	....	1,480,453
Gravel..................do...	1,500	500			
Hay ....do...	400	4,800	SHIPPED.		
Scrap iron ....do...	100	1,750	Lumber ....feet..	1,500,000	30,000
Sand.....................do...	100	50	Coal ....tons..	500	2,500
Limestone ....do...	125	500	Gravel...............do...	100	50
Cedar posts........pieces..	1,200	85	General merchandise.do...	4,636	30,000
Brick and tile.........do...	15,000	1,000			
Beans ....bushels..	100	200	Total....................	....	62,550

The above commercial statistics were supplied by the collector of customs in response to the usual request for them.

Q Q 7.

IMPROVEMENT OF OTTER CREEK, VERMONT.

The object of this improvement is to afford a channel of navigable width and a depth of 8 feet at low water from the town of Vergennes, Vt., to Lake Champlain. The original project was adopted in 1872, and was estimated to cost $58,146. In 1882 surveys developed the fact that rock in situ would be encountered within the proposed limits of width and depth and the estimate was increased to $73,748.40. In 1884 a relocation of the channel at Bull Brook Bend avoided part of the rock excavation, reducing the cost by about $500, and the lower prices which have prevailed in recent years have insured the completion of the project for less than the revised estimate of 1882.

Occasional expenditures for maintenance will doubtless be required. It has been found necessary to repeat operations at Bull Brook Bend, and it is quite probable that accretions will again occur on the shoals there and elsewhere during the season of freshets. Such cost of maintenance will not, it is believed, be excessive in relation to the first cost of the improvement, and they will be very small as compared with the traffic benefited.

Under the act of 1892, which appropriated $10,000 for this work, a contract was entered into with Rogers & Fitzpatrick, of Plattsburg, N. Y., for the excavation of 2,000 yards of rock at $4.44 per cubic yard. Operations under this contract began in July, 1893, and were completed in January, 1894. The projected channel is now open to the public landing and within 500 feet of its upper terminus. Above this point the channel was dredged to rock during the season of 1891. To complete the project this length must be excavated to the proposed depth of 8 feet below low water. The volume of rock to be taken out is 3,700 cubic yards. In addition to this a large bowlder at Bull Brook Bend should be removed and a cut made through a hard shoal at the mouth of the creek to avoid a very abrupt turn.

Appropriations aggregating $51,500 have been made for this work, which, deducted from the revised estimate of $73,748.40, leaves a balance due the improvement of $22,248.40.

Money statement.

July 1, 1893, balance unexpended	$9,710.25
June 30, 1894, amount expended during fiscal year	8,188.88
July 1, 1894, balance unexpended	1,551.37
Amount (estimated) required for completion of existing project	20,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Name, Otter Creek, Vermont; nearest light-house, Split Rock; collection district, Vermont

Arrival and departure of vessels, 1893.

Character of craft.	Arrivals.		Departures.	
	No.	*Tons.*	*No.*	*Tons.*
Unrigged	57	6,750	57	6,750
Sail	5	300	5	300
Steam tugs	303	2,493	300	2,469
Steam vessels	604	5,254	604	5,254

Total tons of merchandise arrived and shipped, 1893.

Articles.		Shipped.	Arrived.
Coal	tons		500
Iron	do		800
Lumber	feet		1,350,000
Nails	tons	500	
Kaolin	do	75	
General merchandise	do	400	
Sand and gravel	do		300

Q Q 8.

IMPROVEMENT OF TICONDEROGA RIVER, NEW YORK.

The project for this improvement was adopted in 1891, its object being the formation of a channel of navigable width and a least depth of 8 feet at low water between the falls of Ticonderoga and Lake Champlain, a distance of about 2 miles. (See Report of Chief of Engineers, 1891, p. 726.)

The improvement was estimated to cost $42,516, of which amount $16,500 have been appropriated and $26,016 are still due the improvement. The appropriation of September 19, 1890, was expended under contract dated January 12, 1891, with Willard Johnson, of Fulton, N. Y., in dredging 8,132 cubic yards from shoal places near the mouth of the river. Operations commenced May 7 and were completed May 21, 1892. In order to carry out the scheme of improvement the existing channel will require very general widening and deepening.

Money statement.

Amount (estimated) required for completion of existing project	$26,016.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	26,016.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Q Q 9.

IMPROVEMENT OF NARROWS OF LAKE CHAMPLAIN, NEW YORK AND VERMONT.

The original project for this work was adopted in 1885, and had for Whitehall, N. Y., and a point a mile below, known as the Elbow, as its object the removal of such obstructions in the channel between would afford a least depth of 12 feet with a least width of 150 feet, and the dredging of the channel along Cedar Mountain and across Kenyon Bay so as to afford a least depth of 12 feet and a width of 200 feet. The estimated cost was $80,000.

In 1886 and 1888 appropriations aggregating $45,000 were made, with which sum, owning to very low prices, the project was completed, leaving a balance in hand of over $2,500.

In the winter of 1889–'90 a survey was made from Whitehall to Benson Landing, on which was based a supplementary project involving 92,000 cubic yards of dredging at an estimated cost of $21,000, distributed among three points, known as South Bay, Beacon No. 3, and Chiltons Bends. In the act of July 13, 1892, the sum of $18,500 was appropriated, making, with the balance in hand, substantially the amount estimated for the execution of this project. Bids for the work were opened September 8, 1892, and the award made to Lynch & Hannan, of Ogdensburg, the lowest responsible bidders, at the rate of 15 cents per cubic yard. Operations commenced in July and were completed in October, 1893. The total amount of material removed was 89,818 yards.

Money statement.

July 1, 1893, balance unexpended	$20,761.16
June 30, 1894, amount expended during fiscal year	15,162.35
July 1, 1894, balance unexpended	5,598.81

COMMERCIAL STATISTICS.

Number of boats, tows, and tonnage that passed into and out of Whitehall Harbor, New York, during the year 1893.

Whole number of tows	220
Average number of boats in a tow	21
Total boats towed	4,658
Number tons to a boat	145
Total tons carried	675,410
Value of cargoes:	
Arrived	$4,200,000
Departed	3,675,000

APPENDIX R R.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENT.

1. Oakland Harbor, California.

HARBOR LINES.

2. Eastern shore of San Francisco Bay, from Point San Pablo southward in front of Oakland and Alameda, Cal.
3. Oakland Harbor, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 5, 1894.

GENERAL: I have the honor to transmit herewith annual report upon work of improving harbor at Oakland, Cal., for the year ending June 30, 1894.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

R R 1.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

OPERATIONS OF THE YEAR.

Operations in the field were directed by Assistant Engineer L. J. Le Conte, assisted by one and at times two inspectors.

The field work consisted in laying out and supervising work of contractors, in monthly measurements and estimates, in a hydrographic survey at the close of the year, and in miscellaneous services.

No contracts were entered into during the year. The work performed during the year was under two contracts, made in the previous year, as follows, namely:

1. Contract with Patrick O'Neil, made October 3, 1892, for supplying from Angel Island 20,000 tons of stone, placing it on the western end of the south jetty, and for laying up about 60,000 square feet of dry masonry on this jetty. The time allowed for performance of the work was extended to December 4. The contract was fulfilled on December 4, having been delayed by stress of weather and other causes. Amount of stone furnished under contract is 19,867.8 tons, of which 12,260 tons were delivered during the year. Amount of masonry laid during the contract is 48,890 square feet, of which 28,206 square feet were laid during the year. The length of jetty faced and finished is 2,465 feet. The price paid per ton was 83 cents, and for facing 12 cents per square foot.

2. A contract with John Hackett for two separate pieces of channel, dated October 8, 1892.

(1) For channel in front of Brooklyn, which work was nearly finished at the close of the last fiscal year, and was fulfilled on July 24, 1893. The amount of dredging was 196,261 cubic yards, and the price was 12 cents. The amount dredged during the year is 35,089 cubic yards.

(2) For channel in front of city of Oakland, extending from Webster street downstream for a distance of 4,300 feet, 250,000 cubic yards, more or less, at 40 cents per cubic yard, to be begun on or before June 15, 1893, and to be fulfilled April 15, 1894. It was begun November 16, 1893, and at close of the year it was not half finished.

The time for fulfillment has been extended to October 15, 1894. The price is 40 cents per cubic yard. The depth required is 20 feet. The depth of dredging varies from 2 to 6 feet. The width is 300 feet.

The material is a hard, sandy clay, holding an occasional cobblestone, and in some places blue clay, which is comparatively easy to handle. It was found necessary to devise new arrangements in order to dig the harder clay, and at first progress was extremely slow. Afterwards 40 to 50 cubic yards were dredged to the engine hour. The amount dredged during the year is 109,765 cubic yards.

MEASUREMENT.

Measurement of dredging is made in place. The method of measurement consists in calculations based upon comparative surveys made before the ground is attacked and at the close of the month. The results of these surveys are platted on maps. Each month work thereon is shown separately. The calculations are made by the assistant engineer, upon whose report the monthly payment is made. At the close of the contract these calculations are independently revised by the assistant engineer and by the engineer assistant in the office. Upon the result of this revision final payment is made. In addition, the officer in charge, before settlement with the contractor, goes over the ground and checks the results reported by his assistants. The inspector also goes over each day's work on the next day, sounding with a pole to note shoal places, to which he calls the attention of the assistant engineer.

Measurement of stone is made by displacement, noted on four gauges made fast to the barge. The values of displacement are experimentally determined by weighing a barge load by scales and noting displacements due to different weights.

ENGINEERING METHODS.

Dredging work, including deposit ashore behind bulkheads or levees, was done by the Von Schmidt pump dredge. This machine has been described in detail in former reports. The improvements introduced since that date consist in having ball joints on the pontoon train leading to the shore line and in adding a system of steel knives to the original cutting apparatus. These knives vary in size and shape to suit the character of the material. The material excavated is forced through 1,200 to 1,500 feet of 20-inch wrought-iron pipe by means of a centrifugal pump, which is capable of throwing a stream equal to 30,000 gallons per minute of clear water.

The delivery of stone on the jetty was done by means of light-draft barges, or lighters, the distance of towage being about 6 miles from the quarry to the site of the jetties. The quantity of stone on each barge load was determined by means of displacement. The laying up of dry stone masonry facing is done with floating derricks having a 60-foot boom. The largest stones from the quarry are kept for the facing work. The stones are all laid as headers, i. e., the longest dimension at right angles to the slope, and fitted closely together by hand labor, and all the voids well chinked up with small stone. The facing stones on this contract generally average from one-half to 3 tons in weight.

The crest of the outer section of the south jetty is 6 feet wide; the weather slope 1 on 2, down to low-water line. The foot of the slope is held firmly by a massive riprap foot wall, 10 feet wide, made of large stone only, the crest being placed at 1 foot above low water.

The other slope of the jetty, next to the jetty channel, is not subject to heavy seas, and the slope adopted is a natural one made of large size riprap.

The depth of water along this section varies from 6 to 12 feet at low tide.

MINOR OPERATIONS.

For some years there has been a growing accretion of sand on the south side of the south jetty, near its shore end, which has begun to overtop the stone line and flow into the harbor. This point needed attention, and during the year 1,410 tons of stone were placed on the line, covering a distance of 1,035 feet, bringing it up to full high-water mark. The cost per ton was 83 cents. The work was done in December and January.

DAMAGE BY STORMS.

The facing of the south jetty was injured to a small extent during a southeast gale by impingement of heavy driftwood and wreckage.

PRESENT CONDITION OF THE WORK.

The condition of the harbor channels is shown by the result of a hydrographic survey recently made, extending from the eastern end of the harbor to a point in San Francisco Bay 1,000 yards west of the western ends of the jetties, a distance of nearly 6 miles. This condition is, that at the eastern end there is a slight shoaling, reducing the depth from 8 to 7½ feet. With this exception the channels have maintained themselves during the year, affording 14 feet at low water from San Francisco to Webster street. This permits a vessel of 19 feet draft to reach Oakland at high water, by a channel 300 feet in width. The portion of the channel in front of the city of Oakland, for nearly a mile in length, is now undergoing dredging, and presents depths between 14 and 20 feet at low water. Upon fulfillment of the contract now in process of fulfillment it is expected that there will, over this part of the channel, be a depth of 20 feet at low water.

THE JETTIES.

The north jetty has not received attention during the year. It is completed, with the exception of facing its terminal mound. Its length is 9,203 feet. The present length of the south jetty is 12,108 feet, all of which is finished and faced except 150 feet at its western end. This jetty is to be extended 550 feet, making its final length 12,568 feet.

FUTURE OPERATIONS.

There remain for completion of the project to deepen the channel by dredging to 20 feet at low water, there being now 14 feet over a length of 4,900 yards; to excavate the canal, to build a dam at mouth of San Leandro estuary, and to extend the south jetty for a distance of 558 feet.

With adequate appropriations several of these separate works could be carried on simultaneously. Otherwise, operations will have to be confined to one or two of these heads. Extension of deep water to San Francisco Bay is regarded as of the greatest relative importance, and together with it, completion of the jetties.

Appropriations for improving harbor at Oakland, Cal.

June 23, 1874	$100,000	July 5, 1884	$139,600
March 3, 1875	100,000	August 5, 1886	60,000
August 4, 1876	75,000	August 11, 1888	350,000
June 18, 1878	80,000	September 19, 1890	250,000
March 3, 1879	60,000	July 13, 1892	150,000
June 14, 1880	60,000		
March 3, 1881	60,000	Total	1,684,600
August 2, 1882	200,000		

Money statement.

July 1, 1893, balance unexpended		$132,955.86
June 30, 1894, amount expended during fiscal year		67,965.95
July 1, 1894, balance unexpended		64,989.91
July 1, 1894, outstanding liabilities	$9,008.68	
July 1, 1894, amount covered by uncompleted contracts	51,094.00	
		63,102.68
July 1, 1894, balance available		1,887.23
Amount (estimated) required for completion of existing project		841,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		300,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following tables, compiled by Assistant L. J. Le Conte, show the respective volumes of business passing between the jetties in the years named. The freight carried by ferry steamers represents miscellaneous freight difficult to classify, and includes the San Francisco trade over the main system of the Southern Pacific Railroad. The classified freight, embracing staples, carried by sail, amounts to 306,865 tons, composed as follows:

	Tons.
Coal	116,600
Iron	1,500
Grains	5,500
Lumber	95,145
Other building materials	80,12
Miscellaneous	8,000

The gross amount is less than in 1893, owing, doubtless, to reduced activity in business. The great increase in passenger travel is due to reduction of fares and the establishment of additional ferries.

Year.	Traffic by steam ferries.				Traffic by vessels.		
	Number.	Trips.	Passengers.	Freight.	Number.	Register.	Freight.
				Tons.		*Tons.*	*Tons.*
1874	1	600	None.	60,000	1,415	70,750	94,300
1878	3	5,400	216,240	129,000	1,085	109,125	211,627
1881	3	8,800	858,352	1,051,788	1,120	129,714	173,448
1882	3	9,400	892,210	1,150,379	1,004	144,004	257,614
1883	3	8,000	974,901	1,142,918	1,031	143,886	215,829
1884	3	8,000	1,553,769	1,202,230	1,156	163,553	255,738
1885	3	6,000	444,142	1,439,134	1,326	200,226	305,437
1886	3	6,000	318,402	1,487,924	1,673	188,974	264,050
1887	3	8,520	210,423	1,654,451	1,224	130,913	231,669
1888	3	8,520	200,000	1,876,635	1,384	162,957	295,932
1880	3	8,600	100,000	1,755,247	1,745	185,358	338,123
1890	3	8,600	100,000	1,925,957	2,153	213,971	393,478
1891	3	8,600	100,000	2,259,086	2,310	232,706	437,923
1892	3	8,600	96,000	2,202,170	2,277	223,148	443,011
1893	5	10,521	506,125	2,142,460	1,686	195,090	306,865

The following comparative grand totals of traffic through the jetty channel show the growth of water transportation in the past nineteen years:

General traffic.	1874: Before improvement.		1893: After improvement.	
	Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*
By ferries	None.	60,000	506,125	2,142,460
By vessels	None.	94,300	....	306,865
Grand total	....	154,300	506,125	2,448,325

R R 2.

ESTABLISHMENT OF HARBOR LINES ON EASTERN SHORE OF SAN FRANCISCO BAY, FROM POINT SAN PABLO SOUTHWARD, IN FRONT OF OAKLAND AND ALAMEDA, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 3, 1893.

GENERAL: I have the honor, on the part of the Board of Engineer Officers constituted by Special Orders No. 5, Headquarters, Corps of Engineers, October 11, 1888, to forward herewith, for the consideration of the War Department, a tracing* showing harbor lines on the shore of San Francisco Bay, opposite to this city, adopted by the Board for recommendation at a session held this day.

* * * * * * *

Very respectfully, your obedient servant,
G. H. MENDELL,
Colonel, Corps of Engineers,
Chairman of Board.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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*Not printed.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 10, 1893.

Respectfully submitted to the Secretary of War with recommendation that the lines proposed by the Board of Engineers constituted by paragraph 2, Special Orders No. 51, Headquarters Corps of Engineers, October 11, 1888, for harbor lines on eastern shore of San Francisco Bay, in front of Oakland and Alameda, and shown on the accompanying tracing, be approved.

It is further recommended that the approval be placed both on this paper and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *October 11, 1893.*

Approved as recommended by the Chief of Engineers.

DANIEL S. LAMONT,
Secretary of War.

R R 3.

ESTABLISHMENT OF HARBOR LINES IN OAKLAND HARBOR, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 20, 1893.

GENERAL: I have the honor to forward, in a separate roll, a tracing* exhibiting the harbor lines of Oakland estuary, recommended by the Board of Engineer Officers constituted by Special Orders No. 51, Headquarters, Corps of Engineers, October 11, 1888, at a session held on the 18th instant. The description of the lines may be found on the tracing by references to established streets in the city of Oakland.

* * * * * * *

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 27, 1893.

Respectfully submitted to the Secretary of War with recommendation that the harbor lines proposed by the Board of Engineers and shown on the accompanying tracing be approved.

It is further recommended that the approval be placed both on this paper and the tracing submitted.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

WAR DEPARTMENT, *September 29, 1893.*

Approved.

DANIEL S. LAMONT,
Secretary of War.

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*Not printed.

APPENDIX S S.

IMPROVEMENT OF RIVERS AND HARBORS IN SOUTHWESTERN ARIZONA AND IN CALIFORNIA SOUTH OF SAN FRANCISCO.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Napa River, California.
2. Redwood Creek, California.
3. San Luis Obispo Harbor, California.
4. Wilmington Harbor, California.
5. San Diego Harbor, California.
6. Colorado and Gila rivers, at Yuma, Ariz.

HARBOR LINES.

7. Napa River, at Napa, Cal.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 7, 1894.

GENERAL: I have the honor to transmit herewith reports upon the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

S S 1.

IMPROVEMENT OF NAPA RIVER, CALIFORNIA.

The project upon which the improvement of this river has been carried on contemplates the removal of snags and leaning trees dangerous to navigation and the deepening of the channel over the bars between Carr Bend and Vernon Mills, in the immediate vicinity of Napa City.

Work has been suspended for several years, owing to the fact that no appropriations have been made for continuing the improvement. The last work was done in 1891, when the river was cleared of snags and a good channel was dredged through the bars from Carr Bend to the highway bridge at Third street. A survey made in August last for the purpose of establishing harbor lines at Napa City showed that the dredged channel had been to a great extent refilled, due to material brought down from the uplands during the winter floods. It is considered that no improvement of a permanent character can be effected, as a channel dredged one year is liable to be entirely obliterated by the floods of the succeeding winter.

In Napa River ordinary tides rise about 5 feet and spring tides about 7, so that under these favorable conditions it is possible, with a comparatively small amount of dredging each year, to maintain the river in a good navigable condition for the class of vessels engaged in the trade. The difficulty has been that the small appropriations made for the work have been insufficient to meet the requirements, as it was not possible to induce any contractor to undertake the dredging except at a figure entirely too high for the amount of work needed for the improvement that season. The last contract let for dredging was at 44 cents per cubic yard, which permitted only a small amount of work to be done. With liberal appropriations all needed work could be done at reasonable cost.

On June 5, 1893, the Napa Valley Wine Company requested that harbor lines be established in front of Napa City, and a Board of Engineer Officers was constituted for the purpose by Special Orders No. 28, from Headquarters, Corps of Engineers, July 14, 1893. The Board submitted its report, with map showing lines recommended, which received the approval of the Secretary of War October 18, 1893.

The estimated cost of the first improvement, made in 1885, was $27,500, of which $17,500 has been appropriated as follows:

Act of—	
August 11, 1888	$7,500
September 19, 1890	10,000

The total amount expended to close of fiscal year, including outstanding liabilities, is $17,480.65.

Money statement.

July 1, 1893, balance unexpended	$19.35
July 1, 1894, balance unexpended	19.35
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor act of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

[Furnished by Capt. N. H. Wulff, Napa City, Cal.]

	1884.	1893.
Merchandise, general, received and shipped ... tons.	22,800	12,100
Coal received ... do...	5,000	26,700
Hay, received and shipped ... do...	2,000	4,500
Grain, feed, and flour received and shipped ... do...	3,000	8,450
Lumber received ... do...	18,333	5,243
Wine received and shipped ... do...	7,500	17,250
Miscellaneous freight received and shipped ... do...	5,936	4,350
Total	64,569	78,593
Steamers	2	2
Tonnage	176	430
Trips by schooners		337

No new lines of transportation were established during the year.

S S 2.

IMPROVEMENT OF REDWOOD CREEK, CALIFORNIA.

The project contemplates providing a channel 50 feet wide and 3 feet deep at mean low tide from the lower end of the Tannery Bend to the wharves at Redwood City, a distance of about 6,000 feet. From the Tannery Bend to the Bay of San Francisco there is at all stages of tide a channel of sufficient depth for the class of vessels engaged in the trade.

No work was done during the past year and none is contemplated for the coming season. Under appropriations made for Redwood Harbor and Redwood Creek the channel has been dredged several times, but has refilled, owing to local causes. It is possible to maintain the channel only by constant dredging. Appropriations will be needed in the future for this improvement, should the commerce of Redwood City justify the expenditure.

No appropriation is asked for the next fiscal year.

The total amount appropriated for dredging at Redwood is $23,400, as follows:

Redwood Harbor:	
Act of July 5, 1884	$3,000
Act of August 5, 1886	5,000
Act of August 11, 1888	7,400
Redwood Creek:	
Act of September 19, 1890	8,000

The total amount expended, including outstanding liabilities, to the close of the fiscal year, is $23,386.49.

This work is in the collection district of San Francisco.

Money statement.

July 1, 1893, balance unexpended	$13.51
July 1, 1894, balance unexpended	13.51

S S 3.

SAN LUIS OBISPO HARBOR, CALIFORNIA.

The approved project is to construct a breakwater on Whaler Reef at Port Harford extending from Point San Luis to Whaler Island, and thence to a point where the reef at its outer point rises above high water. Its total length when completed, including the island, will be about 2,300 feet. The breakwater will rise to a height of about 6 feet above high water, with a thickness on top of 20 feet, and with such side slopes as will be assumed under the action of the sea.

At the commencement of the fiscal year operations were in progress upon the construction of the breakwater under contract with A. A. Polhamus. At that time the structure had been practically completed between Point San Luis and Whaler Island, a length of about 300 feet, and the part beyond the island had been carried a further length of about 340 feet. Operations were continued until October 12, when heavy seas completely wrecked the contractor's outfit for handling stones on the breakwater, and caused a suspension of operations for the winter. The breakwater had at that time been extended to a point

507 feet beyond the island and had reached the shallowest part of the reef. The outer portion of the structure was in an unfinished condition and the seas, striking first the unprotected end, moved the stones inwardly toward the harbor side, and as the destruction gradually extended backward, the last 100 feet was thrown slightly out of line. The remainder of the breakwater was practically uninjured. It seems probable that most of the damage to the wall could have been averted had the end been fortified, as was the intention to do at the completion of the season's work. During the winter several severe storms occurred with but little additional damage to the outer wall. Some of the stones in that portion between the point and the island were displaced, and some slight gaps were made in the work, but without any danger, it is thought, to its stability. In future operations it is intended to first repair these breaks.

As the contractor was unable to continue work, he applied for and received an extension of nine months' time to complete his contract. Work was resumed on the 23d of June and continued to the end of the year. During the past season's operations 9,620.5 tons of stone were delivered and placed upon the breakwater.

The damage to the outer work has caused the material near the end to form a broader base, upon which it is possible to erect a stronger superstructure and at the same time correct the alignment in the work. Operations will be carried on with this view to the end of the present contract. The contractor has yet to deliver about 4,000 tons of rock, which will complete the breakwater to the point reached when the storm of October 12 struck it.

The breakwater as far as constructed has added to the security of vessels lying at the anchorage and wharf at Port Harford. During the October storm steamers laid at the wharf and unloaded, when without the protection of the breakwater and under the sea conditions prevailing they would have been obliged to go to moorings for safety.

The conditions of heavy seas and winds and the fact that no rock suitable for the construction can be obtained in the immediate vicinity adds greatly to the difficulties of carrying on the work at Port Harford with the amounts that usually have been appropriated. It is not possible under the circumstances to induce contractors to undertake the work except at high figures, as the funds made available would not justify such extensive plants as are really needed to perform the work in a proper manner. The result has been that the contracts have usually gone to bidders who have had to resort to makeshift devices to carry out their contracts, at expense to the work and delays in its execution. It is recommended, as has been done on former occasions, that suitably large appropriations be made for the work.

Appropriations in the future will be applied to further extension and repairs of the breakwater.

The total amount appropriated for this improvement is $95,000, as follows:

Act of—	
August 11, 1888	$25,000
September 19, 1890	40,000
July 13, 1892	30,000

And the total amount expended, including outstanding liabilities, is $84,906.48.

The amount that can be profitably expended during the fiscal year ending June 30, 1896, is $150,000.

Money statement.

July 1, 1893, balance unexpended		$28,916.26
June 30, 1894, amount expended during fiscal year		17,739.87
July 1, 1894, balance unexpended		11,176.39
July 1, 1894, outstanding liabilities	$1,082.87	
July 1, 1894, amount covered by uncompleted contracts	10,021.43	
		11,104.30
July 1, 1894, balance available		72.09
Amount that can be profitably expended in fiscal year ending June 30, 1896		150,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

[Statistics for both years furnished by the Pacific Coast Railway.]

	Year the improvement began (1888).		Year ending December 31, 1893.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam .... number	603	603	508	508
Sailing .... do	34	34	12	12
Total	637	637	520	520
Tonnage	452,149.34	452,149.34	397,450	397,450
Draft, greatest .... feet	18	....	....	....
Merchandise, general .... tons	8,802	5,669	9,725	4,489
Coal .... do	2,985	....	560	....
Lumber .... feet	8,884,400	....	5,752,400	....
Grain .... tons	....	23,305	....	30,264
Bituminous rock .... do	....	15,342	....	6,916
Dairy produce .... do	....	....	....	1,685
Live stock .... do	....	....	....	2,968
Chrome ore .... do	....	....	....	149
Asphaltum .... do	....	....	....	133

	Tons.
Total amount of freight entered and cleared in 1888	68,425
Total amount of freight entered and cleared in 1893	64,867

No new lines of transportation have been established during the year.

S S 4.

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

The present project contemplates gaining a depth of 16 feet at mean low tide at the entrance and in the inner harbor. For this purpose jetties have been constructed from Rattlesnake Island and Timms Point on the easterly and westerly sides of the harbor, respectively, and a certain amount of dredging has been done in the inner basin.

Previous to the commencement of operations in 1871, there was a depth of less than 2 feet at the entrance at mean low tide. The operations of jetty extension and dredging have resulted in securing a depth of 16 feet and over in the inner harbor at mean low tide and about 14 feet at the entrance.

Work was continued during the fiscal year from July to November in raising the east jetty between Deadmans Island and the double timber work, in extending the east jetty about 425 feet seaward beyond Deadmans Island, and in raising and extending the west jetty. The stone for the past season's work, amounting to 12,385 tons, was delivered under contract made the previous year, and the work of placing same in position upon the jetties was done by hired labor with the plant owned by the Government.

While these operations were in progress a series of current observations were conducted, and a number of borings were made at the entrance to determine the character of the underlying strata at that locality with a view to the consideration of further projects for improving the harbor. A survey of the inner harbor as far as the head of Smiths Island was also made in connection with work proposed for deepening the channel between harbor lines.

A survey made after the close of operations showed a depth of about 14 feet at mean low tide at the entrance. Advices lately received indicate a deepening at this locality, but to what extent can not be definitely stated, but sufficient to warrant the belief that the channel is undergoing some change for the better. On May 15 the ship *Forrest Queen*, drawing 18.9 feet, entered the harbor easily, the stage of tide being 5.6 feet. Owing to shallow depth along the wharf front where she intended to make her berth she was unable to unload except at high stages of tide. This latter circumstance indicates the necessity of measures being adopted to increase the depth of the inner harbor at various points so as to accommodate the class of vessels that can pass the entrance. If the depth of 16 feet at mean low tide at the latter point be gained it will permit vessels drawing from 20 to 22 feet to enter at high tide, and provision should be made for this circumstance. The changes of depth at the entrance, due to the extension of the jetties, take place very slowly, and it is possible that the ultimate depth of 16 feet will be obtained without any further addition to the works. Should this not occur it might be desirable to resort to dredging, as the removal of a comparatively small amount of material would give the required depth, and this could be maintained at moderate expense.

The inner harbor was dredged several years ago to the depth of 16 feet at mean low tide from the wharves to Deadmans Island over a channel width of 300 feet. The survey shows that this depth has been maintained and that no deterioration of the channel has taken place due to material brought into the harbor during the tidal flow. It is therefore believed that equally good results can be obtained and maintained by further dredging. Along the wharf fronts, which are on the harbor lines, it is found that shoal places exist which prevent vessels from unloading at all stages of tide. At the northerly wharves on the westerly side of the harbor the depth decreases to about 14 feet at mean low tide, and along the entire wharf front of the easterly side of the harbor depths not exceeding 12 feet are found at same stage. These shallow depths indicate the necessity of dredging operations to accommodate the commerce of the harbor, when, as shown above, vessels drawing nearly 19 feet have passed the entrance. Appropriations made in the future will be expended in increasing the depths at the entrance and in dredging the interior basin between harbor lines.

The total amount appropriated for this harbor is $955,000, as follows:

March 3, 1871	$200,000	March 3, 1881	$33,000
June 10, 1872	75,000	August 2, 1882	100,000
March 3, 1873	150,000	July 5, 1884	50,000
March 3, 1875	30,000	August 5, 1886	75,000
June 18, 1878	20,000	August 11, 1888	90,000
March 3, 1879	12,000	September 19, 1890	34,000
June 14, 1880	35,000	July 13, 1892	51,000

The total amount expended to close of fiscal year, including outstanding liabilities, is $950,213.68.

Money statement.

July 1, 1893, balance unexpended	$38, 880. 48
June 30, 1894, amount expended during fiscal year	34, 019. 16
July 1, 1894, balance unexpended	4, 861. 32
July 1, 1894, outstanding liabilities	75. 00
July 1, 1894, balance available	4, 786. 32

COMMERCIAL STATISTICS.

Commercial statistics for the year the improvement began (1871).

	Incoming.	Outgoing.
Vessels:		
Steam ... number	160	160
Sailing ... do	65	65
Total	225	225
Freight ... tons	25, 313	9, 575
Lumber ... feet	10, 938, 336	...

Statistics of commerce for the year ending December 31, 1893.

[Furnished by the collector of customs at Wilmington, Cal.]

	Foreign commerce (outer harbor).		Domestic commerce.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam	4	4	293	293
Sailing	34	23	165	162
Total	38	27	458	455
Tonnage	239, 090	223, 649	...	...
Draft, greatest	26	14	18½	...
Merchandise, general ... tons		4, 162	15, 244	13, 372
Coal ... do	86, 439	...	...	...
Cement ... do	4, 295	...	...	...
Lumber ... feet	...	...	78, 045, 000	...

The total amount of revenue collected at the port during the year ending December 31, 1893, was $140,858.

The rates on freights have been reduced since the first expenditure for the improvement of this harbor from $7.50 to 62½ cents per 1,000 feet on lumber, and from $5 to 75 cents per ton on general merchandise from the outer harbor.

	Tons.
Total amount of freight entered and cleared in 1871	50, 059
Total amount of freight entered and cleared in 1893	231, 757
Increase	181, 698

No new lines of transportation were established during the year,

S S 5.

IMPROVEMENT OF SAN DIEGO HARBOR, CALIFORNIA.

The approved project for the improvement of San Diego Harbor contemplates the construction of a jetty on Zuninga Shoal at the entrance to the harbor; the maintenance of a channel of 24 feet depth at mean low water through the middle ground; and the repair of the dike built across the mouth of the San Diego River to divert the waters of that stream into False Bay.

Jetty.—It is intended to construct a jetty about 7,500 feet in length, extending from Coronado, North Island, along Zuninga Shoal, with a view of gaining 26 feet at mean low tide over the outer bar where now there is a depth of about 21 feet at same stage. Zuninga Shoal projects out from Coronado, North Island, parallel to Point Loma Peninsula, the line of its crest being about 1,400 feet eastward of the entrance. In its natural condition it has the appearance of a submerged jetty, with an average depth along its crest of about 3 feet at mean low water. Before the commencement of operations there was a littoral channel along the shore end, having a depth of about 11 feet at same stage. The alignment of the jetty will be along the crest of the shoal, and the structure will be simply a mound of stone on a brush foundation and carried to about high-water mark, which will have the effect of raising the shoal to that height.

Specifications were issued and proposals were invited for the construction of so much of the jetty as the funds available would permit. A contract was entered into August 30, 1893, with Silas R. Smith, the lowest bidder for work, at the following prices: Trestle, $5.91 per linear foot; brush mattresses in place, at $2.53 per cubic yard; stone, $1.62½ per ton of 2,240 pounds; and office building at $550. Work was commenced in September, but owing to the insufficient plant provided by the contractor but little progress was made. In January of this year a change was made in the outfit, and operations since have been conducted in a satisfactory manner. Owing to the delays occasioned in the earlier operations, the contractor was unable to complete the work in the stipulated time, and accordingly an extension of three months was granted him.

The operations consisted first in revetting the shore for a length of about 1,000 feet from the point selected for root of the jetty westward to the entrance channel, and afterwards in commencing the construction of a trestle from which the mattress and rock could be deposited on the line of the jetty. The line selected is well back from the approach to the entrance so as to afford considerable latitude for building spurs and keeping the channel from the main structure and so avoid dangers from undermining.

The masses of stone for the revetment and for the jetty proper were deposited upon a foundation of brush and stone. The mattresses for the former were simply laid in place upon the beach; those for the jetty were built upon the trestle and dropped into position. The details of the mattress construction and methods of sinking are given fully in the accompanying report of the assistant in local charge of the work. The specifications called for the construction of a trestle with 3-pile bents, but owing to the depths of water in the littoral channel and to the heavy rolling stock used the contractor constructed 84 bents with 4 piles each, and 74 bents as specified. These latter were found to possess all needed stiffness required in the construction. As the trestle advanced seaward its height was increased from 16 to 20 feet above low tide.

At the close of the fiscal year the contractor had completed the following amount of work: 1,000 feet of shore revetment; 2,464.5 feet of double-track trestle; 1,860 feet of jetty to a height of high water; 194 feet additional to low water; and the brush and stone foundation course a further distance of 418 feet. To complete the contract will require about 4,600 tons of stone yet to be deposited on the line of the jetty. It is expected that this work will be done during July.

In conducting the operations, instead of pushing the work bodily forward the foundation course and lower portions of the jetty proper were built a considerable distance in advance of any completed portion, so as to disturb as little as possible the existing conditions.

There was but little local scour in front of the trestle and advanced work. The completed work shows as yet no influence upon the bar depth, and it is not expected that any change will be observed until the jetty has been advanced a considerable distance. The only observable change in the natural conditions is in the shore line near the root of the jetty. To the eastward the low-water line has advanced seaward about 350 feet, and ordinary high-water line about 300. The shore line for a length of about 2,100 feet shows the effect of this filling; on the line of the jetty the vertical depths of the filling over the part affected is from 8 to 11½ feet. On the channel side some filling is observed, due to sand carried through the wall from the eastward and dropped into still water. A shoal that existed to the westward of the jetty line before work was commenced has disappeared since the littoral channel has been filled. Aside from the shore drift there is apparently but a small movement of sand at the locality; this is particularly observable by reason of the slowness in which the brush mattresses silt up. Some of these constructions, which were only a foot thick, showed but little evidence of filling even after a submersion of two or three months.

Middle ground.—No work was done upon the shoal at this point during the past year. The depth remains about the same as last reported, viz, 16½ feet. No work is contemplated until the jetty work shall have been advanced sufficiently to cut off the movement of sand over Zuninga Shoal and thereby permit dredging of the middle ground, with some prospect of maintaining a permanent channel.

Dike.—This work, completed in 1876, had for its object the preservation of the navigation of the bay, which was threatened by the deposition of material brought down by the San Diego River during flood stages. The river was turned from its course and caused to empty into False Bay. This was accomplished by building a dike across the mouth of the river and excavating a new channel. The dike is in good condition. If repairs are found necessary they are made by making a small allotment for the purpose from the appropriations for the harbor.

Work will be continued upon the jetty as now designed to the extent of the funds made available. An appropriation of $200,000 is asked for the fiscal year ending June 30, 1896.

The total amount appropriated for San Diego Harbor since 1875 is $192,500, as follows:

Act of—	
March 3, 1875	$80,000
March 3, 1879	1,000
August 11, 1888	1,000
September 19, 1890	60,500
July 13, 1892	50,000

The total amount expended, including outstanding liabilities, is $174,493.48.

This work is in the collection district of San Diego.

Money statement.

July 1, 1893, balance unexpended		$88, 732. 15
June 30, 1894, amount expended during fiscal year		55, 810. 50
July 1, 1894, balance unexpended		32, 921. 65
July 1, 1894, outstanding liabilities	$14, 915. 13	
July 1, 1894, amount covered by uncompleted contracts	15, 148. 34	
		30, 063. 47
July 1, 1894, balance available		2, 858. 18
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		200, 000. 00

Abstract of bids for building a jetty at San Diego Harbor, California, called for by advertisement dated June 17, 1893, and opened at 11 a. m. July 21, 1893, by Lieut. Charles L. Potter, Corps of Engineers, in absence of Lieut. Col. W. H. H. Benyaurd.

No.	Name of bidder.	Trestle, per linear foot.	Mattress in place, per cubic yard.	Stone, per ton of 2,240 pounds.	Office building.
1	John H. Quinton	$6. 56	$3. 78	$2. 33	$500. 00
2	Kimball G. Easton	9. 44	2. 25	2. 24	500. 00
3	W. Jacobson	5. 17	1. 97	2. 09	800. 00
4	Darby Laydon	7. 28	4. 75	2. 75	775. 00
5	Silas R. Smith	5. 91	2. 53	1. 62½	550. 00
6	J. P. M. Phillips	11. 50	4. 00	3. 00	600. 00
7	Healy, Tibbets & Co	6. 50	2. 40	2. 30	600. 00
8	A. A. Polhamus	10. 00	3. 50	2. 48	550. 00

REPORT OF MR. F. C. TURNER, ASSISTANT ENGINEER.

CORONADO NORTH ISLAND, CALIFORNIA, *July 2, 1894.*

COLONEL: I have the honor to submit the following report of work upon the jetty at San Diego Harbor for the fiscal year ending June 30, 1894:

Work began under the contract with S. R. Smith in September, 1893, but was not vigorously prosecuted until the contractor received financial help from Mr. W. S. Waterman. In January, 1894, the quarry was changed, and since then, with the exception of three delays to brush and trestle work by reason of the nonarrival of piling and lumber, the work has been continuous and active.

The work done up to June 30 is as follows:

An office building has been erected; a 40-ton Howe railway scale put in place on a concrete foundation; 1,000 feet of the shore revetted with rock and brush; 2,464.5 feet of double-track trestle built; the jetty built to high water for a distance of 1,860 feet, to about low water for 194 feet more, and a brush and stone foundation course for 418 feet more, the total length of foundation course being 2,472 feet, or a half bent, 8 feet, beyond the trestle. Besides this work, which was paid for by the United States, the contractor has had the Coronado Railroad extended a mile and a half so as to reach the jetty, and has built the necessary approaches, embankments and side track, and started a wharf on the bay side.

The general plan of the work was to build 1,000 feet of shore revetment from the root of the jetty westward to the entrance channel, after which, on February 2, a high-tide jetty was started out along Zuninga Shoal. The location is well back from the channel so as to give considerable latitude for building spurs and keeping the current from the main structure, the distance of the axis, prolonged straight to the shore, from the entrance to the bay being 460 yards. The jetty starts on a 10° curve concave to the channel, in order to "refuse" the root of the work from wave attack during construction in case of storms, and also to bring the work all opposite land owned by the United States. The curve effects a saving of about 1,400 tons of rock and 280 cubic yards of brush, by reason of shortening the shore revetment 350 feet, while not affecting the volume in the jetty proper. The tangent in the jetty prolonged converges toward the channel, and breakers are outside of it at the end of the shoal, considerable change having taken place since the last survey, so that the direction will probably need changing about 5° to the east to give the cheapest construction.

With the completion of this contract, under which about 4,600 tons more of rock, about three weeks' work, is still to be placed, the foundation course will have been carried to nearly a third of its proposed length, the wall some 200 yards less; but owing to the existence of a channel close to the shore about 250 yards wide and having a depth of 10 feet, while the greater part seaward of it consists of a shoal with but a third as great depths along the axis of the jetty line, the volume actually filled is a much larger percentage of the whole work, that is, on the basis of the present depths. With halting intermittent work considerable scour is likely to occur, and greatly increase the amount of material needed.

The effects of the work done, as far as observed, are only local, and little else is likely to occur until the jetty has been extended 1,000 feet farther. The shore line has built out at the root of the jetty, advancing the low-water mark 118 yards and the ordinary high-water mark from 90 to 95 yards, the vertical depths of filling being from 8 to 11½ feet. On the east side the shore line curves back gently from the jetty, the shore being affected for about 700 yards, but the west side has built up by the sand coming through the wall from the east and dropping into dead water, forming a crescent-shaped beach in the angle between the jetty and the revetment, and a steep bank along the inside of the wall serving to strengthen that side also. It is thought that this tendency to fill will continue along the whole work and the bank remain, if the spurs be built out to the channel. A shoal on the west side of the jetty, which was bare at a foot of tide, has scoured since the littoral channel was closed, so that but a small patch is exposed only when the tide falls below zero. Aside from the shore drift the movement of sand in this protected place and calm latitude has been inconsiderable. At times the water becomes exceedingly clear, and the edges of the brush mattresses can be seen still unsanded over after two and three months' submersion, though they are only about a foot thick. A small local scour has occurred at the end of the shore revetment wall, merely wave swash. No tendency to widen the entrance, as is ultimately expected, has yet been observed.

In view of the general experience of the coast jetty work of a considerable advance scour, the general principle has been observed in the work of disturbing existing conditions a minimum until an inerodable foundation had been laid. The first mile of the shoal being well protected behind Point Loma and the outlying kelp, the sea is very mild. There probably is no place where the local weather is so mild and uniform, even in the winter. As a result the formation mats were covered only with small rock, and the mats were only a foot or less thick, and were projected out rapidly so that at one time they were 1,200 feet ahead of the mound. The average thickness of the foundation course was from 2½ to 3 feet. In building the wall the littoral channel was kept open for most part until the mats had all been laid. The actual scour has been very small, averaging not over a foot, except on the lines of the piling, a pothole from 6 to 18 inches deep usually cutting round each pile. The maximum scour was at the end where the mat was dropped in 5½ and 6 feet of water, while the soundings before beginning work were 2¾ and 3, a scour of 3 feet. The smallness of the scour is due, it is thought, to this being the first work, to the mild weather, to the location of the jetty outside of the crest of the shoal, and to the methods pursued in doing the work.

The depths actually built in varied, beyond the shore, from 10 and 11 feet in the littoral channel to 4 feet on the shoal, the original depths before doing much work being 9 and 10 feet in the channel and 2¾ and 3 feet least depth on the shoal.

The trestle specified had a double track upon bents of 3 piles, bents being 16 feet apart between centers, the level of the top of the stringer being 16 feet below low water. But owing to a clause in the specifications stating that it was designed for light rolling stock, the contractor drove bents of 4 piles for 84 out of a total of 158 bents, the outer 74 bents being as specified. Cars weighing 75,000 pounds gross have been run over these 3-pile bents. No sway bracing has been used and the trestle was amply stiff without it, even before dropping the mats, and with a height of 26 feet above the ground. The piles in the 3-pile bents were driven usually from 11 to 13 feet deep, but one inside pile in a few of the 4-pile bents was allowed to be driven less than the specified 10 feet. All piles were driven with a drop-hammer, overhanging skid driver. The water jet was tried, but the apparatus was not well adapted to that process, the piles went down crooked, and it was finally given up after a few trials. The bottom was medium sand. The usual penetration, with a blow from a hammer weighing 1,800 pounds and falling 24 feet, the rope fixed and overhauling the drum, was from 1¼ to 1½ inches, the average pile being blunt-pointed, about 10 inches in diameter at the small end and about 13 inches in diameter at the butt. With everything running smoothly, a crew of eight men could drive and cap 3½ of the 4-pile bents in eight hours, and at times drove 4. When driving bents of 3 piles, the stringers were picked up from a raft by means of a pair of shearlegs on the rear end of the driver, and with this work added the speed was the same as before with 4-pile bents. With delays and accidents the average was much less than the rate given. The top work of sizing and bolting the stringers and putting in the spreaders was kept up by 4 carpenters. On account of the rapid progress and the small amount of scour, the pile-driver was not held back to the degree specified, but was allowed to get at one time 150 yards ahead of the finished foundation course, and usually was from 60 to 80 yards in advance, thus giving more room for the carpenters and mattressmen. Piles seldom stood more than from 4 to 5 days before the mat was dropped around them. It was decided, after starting work, to increase the height of the trestle from 16 feet to 20 feet above low water. The trestle, accordingly, is on a grade, or rather two grades, with a short level between, on account of the lengths of piles the contractor had on hand, the short level between grades having the appearance of a sag. The last 52 bents are 20 feet above low-water level.

The brush mattresses which form the foundation course are composed of two layers of brush laid at right angles and compressed between top and bottom grillages of 2 by 3-inch pine scantling, and tied with No. 10 black annealed iron wire. Owing to the prevalent idea of the scarcity and high price likely to be bid for brush, the mats were specified very thin. In actual work it was found difficult to get a close mat much less than a foot, which was the average thickness made, except with very fine brush. All but the last mattress were made in one piece under the trestle, in lengths of 4 bents each, and varied according to the depth of water from 25 to 52 feet in width. The end mat was 69 feet wide and 2½ bents long, projecting a half bent beyond the trestle. The widths are enough to allow of a projecting apron or berm of 4 to 6 feet beyond the toe of the rock wall on each side. The brush was a good quality of willow, fairly straight, and with butts usually between ¾ inch and 2 inches diameter, and was delivered on cars in bundles about 8 inches thick and from 6 to 20 feet long—usually about 15 or 16 feet in length. About a sixth of the amount came from the Sweetwater River, the rest from the Tia Juana River, about 160 acres being cleared, I was told, in obtaining some 4,000 yards from this latter locality.

The methods used in making and dropping the mattresses, devised by Mr. W. S. Russell and Mr. George F. Bryant, were modeled after the methods in vogue at the jetties at Tampico, Mexico, and for these exceptionally thin and light mats worked excellently, not one being lost nor badly injured. As the mats were much wider than caps, the latter were extended by outriggers of 6 by 10-inch pine, held to the cap by a bolt going through both cap and outrigger and fastened with nut and washer. In the case of the end mat, 69 feet wide, the 30-foot cap was extended by two or a double outrigger on each side, a second one bolted to the end of the first. It is thought that this mat is the widest ever dropped from this width of trestle. From these outriggers and caps 4 pieces of 3 by 8-inch pine 15 feet long are hung, about 3 feet below the bottom of the caps, to act as suspenders, upon which to lay the grillage and build the mattress. The outside ends of the outer suspenders and the inside end of the pair in the middle of the trestle hung by single ropes fixed to both suspender and cap or outrigger, in case of the outer pieces; but the outer ends hung in the bight of a rope of which one end was tied to the cap, and the other, fitted with an eye, was held in a light iron trip hook, which also hung to the cap; there being 2 trip hooks to each bent, or 10 to a mattress. When ready the mattress is dropped by the levers of these trip hooks being pulled simultaneously at a given signal, the two outer suspenders swinging to the outside, and the two inner ones pulling up through the middle of the mattress. Upon the suspenders the lower grillage is laid, consisting of 2 by 3 inch scantling in 32-foot lengths, placed on edge parallel to the axis of the jetty and 3 feet apart, and crossed by scantling 5 feet apart, the crossings being fastened by nails. The end of a 5-foot piece of No. 10 annealed black iron wire is wound around each grillage crossing, and the wire allowed to project up about 3½ feet. The bundles of brush are then laid in alternately butt and end, cut open and spread, care being taken to keep the wires projecting above it, after which the top grillage, similar to the bottom, is put on and the mattress compressed and tied by heaving on the ends of the wires with mat levers, iron bars with a corrugated toggle at the end, and having a 6-inch fulcrum welded on about 5 inches from the end. The wires are secured by taking a turn round the grillage crossing and twisting the end about a half-driven nail, the nail finally being driven home, the wire being held taut during this operation in a pair of tongs.

About two-thirds of the mattresses were dropped light, but toward the end the increased swell made it advisable to put on a preliminary loading of small rock. The mattresses being so thin, the buoyancy, particularly with green brush, was so small it required but from 4 to 6 tons to sink a mattress containing from 100 to 120 cubic yards. With a foreman and 10 men a mat of this, the usual size, would be sunk in from six to nine minutes after dropping. With light preliminary loading it usually took from two to four minutes, and when well covered about one minute to one and one-fourth minutes to settle securely on the ground.

On the basis of a mat of 100 cubic yards, about 63 feet long, 43 feet wide, and a foot thick, the labor would approximate 90 hours, or with foreman, say one hour per cubic yard of compressed mattress. This was distributed about as follows: Thirty hours on outriggers, suspenders, and lower grillage; forty hours laying brush; and twenty hours putting on top grillage, tying, and compressing; or in money terms at $1.50 per day, foreman $3, the frame would cost, per cubic, yard, 6.6 cents, brush filling 8.8 cents, tying 4.4 cents, or about 20 cents in all. The material, with the waste lumber, wire, and nails, costs about 35 cents, and with brush at $1 per cubic yard at the trestle, makes the total mat, ready for dropping cost about $1.55 per cubic yard. This is the average for 1,212.2 cubic yards of brush which took 1,050 hours besides foreman's time; but takes no account of expense for locomotive, preliminary preparations, and plant; and delays and accidents also bring the average total cost much higher. But it will be seen that the thinness of the mattresses does not increase the cost as much as might be thought. If the thickness were doubled the grillage would need be heavier, at least 2 by 4 inches, or 33 per cent; and the labor would be increased nearly as much, making the cost, aside from the brush and the labor of stowing it, which would change little, about 31 to 32 cents per cubic yard, instead of 46 cents, a probable cheapening of but 14 to 15 cents per cubic yard.

Considering the fact that the sand moves so slowly in this locality in the absence of storms, that thick mats are unlikely to be sanded up from teredo attack for many months; that the difference in cost, per volume, of rock and brush is now in favor of rock, and is not likely to be very much the other way in future contracts, especially if the specifications allow considerable latitude in the sizes of rock, and also taking into account the advantages gained by having a thin advance foundation course—for scour hereafter will be much greater than heretofore—it would seem advisable to continue the use of brush merely as a foundation course or "carpet," and not as a material to fill the heart or core of the jetty, despite its possible greater tightness. That the use of some brush is needed as a foundation would appear to be indicated by the experience on the revetment wall. During the contractor's change of plans a considerable quantity of rock which had been thrown off the cars upon the beach and on the line of the intended wall, had buried into the sand, making it tedious and difficult to pick up and place properly on the brush. Therefore the contractor requested to leave it and have a deduction estimated, which was done. In consequence of this, experiment was tried of leaving out the brush foundation for 100 feet. The result was that during rough water and high tide this portion of the wall sunk down 2½ and 3 feet below the rest of the wall, making a deep sag. This is not a conclusive test of a small stone foundation, however, as there was not a full generous layer of small rock on the sand, only rock from 100 to 250 pounds; but it may be claimed that it was as well covered as would be practicable to count upon under water on the line of the jetty proper, unless there was a large quantity of small rock available, as in case of the Catalina Island quarries, for instance.

The first 1,800 tons of rock delivered last fall came from the Sweetwater Valley and is a hard porphyry—locally socalled—containing crystals of iron pyrites and weighing 168 pounds per cubic feet. It was brittle and splintered in quarrying. Seeing the likelihood of a large amount of small stone, which was excellent for covering the mattresses but useless outside, rock below the specified 50 pounds weight was rejected. The quarry was changed to a coarse-grained granite quarry at Fosters, after Mr. Waterman took hold in January. This rock cleft large, and in order to obtain small stone for sinking the mattresses a porphyry quarry had to be opened at Spring Valley, and was operated several weeks. The large rock was unloaded into the middle of the trestle by means of a chain and trip hook and a car fitted up with a derrick and hoisting engine. After some practice 2,000 tons a week, forty-eight hours, were readily unloaded by the crew of 7 men, and the attending locomotive and its engineer, if they were not kept waiting, and the stone averaged fairly large. One man rock is the cheapest handled—about 40 to 50 per cent cheaper than the derrick. Rock from 500 pounds to 2,000 pounds, I judge, can be most easily handled by crowbars, if loaded in separate cars. All rock was delivered on ordinary 20-ton railroad flat cars, there being about 50 regularly in the service. The loads averaged from 16 to 18 tons, but varied up to a maximum of 25 tons (2,240 pounds). The jetty wall has been formed by dropping the rock between the tracks and allowing it to take its own slope, which is nearly one to one on account of the heaviness and large sizes—from 2 to 3 tons on the average, but running up to 6 and 7 tons—of the rock and the mildness of the sea, there not having been a storm since the start. Several piles have been knocked out from under the caps and had to be pulled back and rebolted, and the caps and stringers have been much scarred by the falling rock. The 20-foot drop is severe on the rock also and many pieces break. A wider space than 16 feet between track centers would give better opportunity for trimming the wall.

In general, the jetty mound was built in three stages. First, the foundation course was laid; next, the wall built to between low and half tide and small rock thrown over it to chink up spaces and tighten it, and then the wall was built up to high water. A final trimming up will be necessary after this last operation.

With present prices of $1.625 per long ton for rock and $2.53 per cubic yard for brush mattresses, assuming a cubic yard of jetty to take 1¼ tons of rock, the cost per cubic yard for stone and for brush would be as $2.17 to $2.53, or the stone 14 per cent the cheaper. The rock wall may not be so tight as the brush core, but by chinking up liberally with small rock, and after the anticipated sanding up has taken place, it is thought there will be no practical difference in this respect. With cheaper brush, as may possibly happen to be the case, the aspect would be different.

All rock and brush have been delivered by the Coronado Railroad, which skirts the southern shore of the bay, and the San Diego, Cuyamaca and Eastern Railway, the total distance from the quarry at Fosters to the jetty being about 51 miles, nearly equally divided between the two roads.

One man has been killed at the quarry by a bowlder rolling upon him, and several have been injured. Three men have been hurt at the jetty in handling rock, and two have fallen from the trestle but without being hurt.

Since the brush work stopped on May 23, from 8 to 12 men have been employed at the jetty, and from 50 to 60 at the quarry.

The material used has been 4,723.2 cubic yards of compressed brush, and 27,769.89 long tons of rock. About 4,600 tons more rock will be delivered under this contract, which will take about three weeks.

Very respectfully,

F. C. TURNER,
Assistant Engineer.

Lieut. Col. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Commercial statistics for the year the improvement began.

	Vessels.	Freight.
	No.	*Tons.*
Entered	201	24,809
Cleared	195	11,647

The vessels (including 109 steamers) had an aggregate tonnage of 122,311 tons.

Commercial statistics for the year ending December 31, 1893.

[Furnished by Mr. A. E. Higgins, special deputy collector.]

		Incoming.	Outgoing.
Vessels:			
Steam	number	242	241
Sailing	do	93	88
Total		335	329
Tonnage		255,074	[illegible]53,217
Draft, greatest	feet	24	24
Merchandise, general, domestic	tons	25,770	(*)
Coal	do	86,068	
Lumber	feet	16,826,000	
Grain	tons		8,733
Merchandise, general, foreign, † valued at		$390,668	$273,993

* Could not furnish figures.
† No record is kept of the amount in tons exported or imported.

Amount of revenue collected at the port during the year ending December 31, 1893, $91,812.

	Tons.
Total amount of freight entered and cleared in 1876	36,456
Total amount of freight entered and cleared in 1893, exclusive of foreign merchandise	143,908
Increase	107,452

No new lines of transportation were established during the year.

S S 6.

IMPROVEMENT OF COLORADO AND GILA RIVERS AT YUMA, ARIZONA.

The section of the river and harbor act of July 13, 1892, making an appropriation of $10,000 for improving the Colorado River called for "the construction of a levee along the Gila River near its junction with the Colorado so as to confine the waters to the channels of said rivers."

A survey of the locality having been made, and the necessary conditions to meet the required object having been determined, specifications were issued and proposals invited for the construction of the levee. Previous to issuing these specifications the right of way had been obtained from the different property owners free of expense to the United States and the deeds therefor had been placed upon record at Yuma.

Proposals for the work were opened September 4 last, and a contract was entered into September 19 with Baker & McKeown for the construction of the levee at a price of 12½ cents per cubic yard.

The levee was commenced in October, 1893, and completed the following January. It has a length of about 3,400 feet, with a crown of 8 feet, and slopes inside and outside of 1 on 2 and 1 on 3, respectively. It rises to a height of 2½ feet above the flood of 1891 in the Gila, the average height being 10 feet. The total amount of material placed in the work was 53,807 cubic yards.

The line extends from Penitentiary Hill to the embankment of the Southern Pacific Railroad, near Seventh and Gila streets, following for the greater portion of its length the westerly bank of a slough along the easterly boundary of Yuma. In adopting this line advantage was taken of a levee of light profile thrown up by the village authorities several years before, as the object to be fulfilled, viz, the protection of Yuma against floods, could be obtained at less cost by following this line rather than a longer one along the bank of the Gila proper. The work is in good condition.

The total amount appropriated for this improvement is $10,000, and the total amount expended is $9,640.09.

An abstract of bids received is appended.

Money statement.

July 1, 1893, balance unexpended	$9,503.07
June 30, 1894, amount expended during fiscal year	9,143.16
July 1, 1894, balance unexpended	359.91

Abstract of bids for building a levee at Yuma, Ariz., called for by advertisement dated July 25, 1893, and opened at 11 a. m. September 4, 1893, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers.

No.	Bidder.	Price per cubic yard.
		Cents.
1	Patrick J. McCormick	13
2	Grant Bros	14
3	J. S. Antonelle & Co	39
4	Humphrey McKeown and John Baker	12½
5	Rudolf Axman	16
6	Redmond Toohey and Henry George	16½

S S 7.

ESTABLISHMENT OF HARBOR LINES IN NAPA RIVER AT NAPA, CALIFORNIA.

NAPA VALLEY WINE COMPANY,
San Francisco, June 5, 1893.

DEAR SIR: Being the owners of property in East Napa, between Sixth and Seventh streets, having a frontage of about 300 feet on the east shore of the Napa Creek, we are quite interested in the preservation and protection of navigation and harbor in Napa City.

In former years wharves and bulkheads were only needed and used in West Napa, but lately manufactories of various kinds have been established on the east side, and make the building of wharves and bulkheads a necessity.

The continuous changes in the creek make it difficult to ascertain the lines where the erection of wharves and bulkheads is justifiable; and as the increased traffic as well as the value of property makes it necessary to define the different personal rights, we would like to make manifest to you that the establishment of harbor lines between the Third street bridge and the foot of Oak street is essential to the preservation and protection of the harbor of Napa; and we respectfully request you to cause such lines to be established beyond which no piers, wharves, bulkheads, or other works shall be extended, or deposits made, except under such regulations as may be prescribed by you.

Respectfully, yours,

NAPA VALLEY WINE COMPANY,
E. C. PRIBER,
Manager.

Hon. DANIEL S. LAMONT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 13, 1893.

Respectfully referred to Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, for investigation and report.

If, in Colonel Benyaurd's opinion, the establishment of harbor lines is essential to the preservation and protection of the harbor he will please submit to this office a map showing the harbor lines which in his judgment should be established by the Secretary of War.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., June 30, 1893.

Respectfully returned to the Chief of Engineers, U. S. Army, with accompanying report.

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 12, 1893.

Respectfully returned to the Secretary of War.

Application has been made by the Napa Valley Wine Company, owners of property fronting on Napa River, at Napa City, Cal., for the establishment of harbor lines at that locality.

Attention is respectfully invited to the report, dated the 30th ultimo, from Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, to whom the application was referred. He is of the opinion that the narrowness of the channel, the small depth of channel when not influenced by tide and other attendant circumstances do not warrant the establishment of harbor lines, and suggests that encroachments upon the navigable channel can be controlled under the provisions of section 3 of the act of Congress of July 13, 1892.

I do not concur in the conclusions reached by Colonel Benyaurd.

In my opinion the narrowness of the channel, instead of constituting an objection, is rather an argument as to the necessity of establishing harbor lines. To a growing and progressive industrial city, situated upon a narrow river, the preservation and protection of its water front from encroachments that tend to diminish the water space is a matter of vast importance. And it is of essential moment to the owners of property bordering on such a river to have their individual rights as to the extension of wharves and other structures defined and settled by law. When harbor lines have been established under the provisions of section 12 of the act of September 19, 1890, the interests of the public in the preservation of the navigable channel are protected, and the rights of individual riparian owners are fixed so that all are on the same footing, and a person on one side of the stream can not extend his wharf or pier out to an unreasonable distance to the injury of the owner of property on the opposite side.

Section 3 of the act of July 13, 1892, simply forbids the erection of structures that may impede navigation, but a structure may offer no obstruction to navigation and yet be decidedly injurious to a harbor. The objects intended to be accomplished by the law providing for the establishment of harbor lines and the law forbidding the erection of structures obstructive of navigation are by no means identical.

I therefore recommend that the matter of the establishment of harbor lines at Napa City be referred to a Board of Engineer Officers to consist of Lieut. Col. W. H. H. Benyaurd, Maj. W. H. Heuer, and Lieut. C. L. Potter.

With the sanction of the Secretary the order constituting the Board will be issued from this office.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT, *July 13, 1893.*

Approved as recommended by the Chief of Engineers.

By order of the Acting Secretary of War:

JOHN TWEEDALE,
Chief Clerk.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., June 30, 1893.

GENERAL: I have the honor to present the following report on the matter of the establishment of harbor lines at Napa City, Cal., called for in your indorsement on letter of E. C. Priber herewith.

The width between banks of Napa River at Napa City, Cal., varies but slightly from a mean of 100 feet. The banks are somewhat bluff, and when the channel way is not encroached upon by bars the width is very nearly the same at high and low stages of tide. The rise of ordinary tides is about 5 feet and of spring tides about 7 feet. The river is subject to considerable freshets which bring down from the uplands floating trees and detritus composed partly of gravel, which settles in the channel and forms shoals. The channel way has been dredged through the worst of these shoals, but owing to the causes just mentioned, the dredged portions have been partially refilled. In all these changes, however, the banks have remained stable. Only small steamers, two in number, with a draft of 4 feet, and small sailing vessels of like draft, are engaged in navigating the river, and even for these vessels continuous navigation is only possible during the higher stages of tide. Arrivals and departures are timed to take advantage of this condition. The narrowness of the river between banks necessarily precludes the erection of extensive wharves. Where these latter are built for the accommodation of business, they extend but a few feet from the banks. The narrowness of the channel between banks, the small depth of channel when not influenced by tide, the changes in the channel way and other attendant circumstances appear to me not to warrant the establishment of the harbor lines asked for. No wharf can be projected to any length without interfering with navigation and such encroachment can be easily controlled under the provisions of the river and harbor act of July 13, 1892. The fact is, that the matter seems to be a personal one between the Napa Valley Wine Company and A. Hatt, the owner of property on the opposite bank of the river. The applicant in a personal interview asked for the establishment of the lines, but considering the views just expressed as the probable reason for the request, I decline to consider the subject.

The letter of Mr. Priber is returned herewith.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF BOARD OF ENGINEERS.

SAN FRANCISCO, CAL., *October 5, 1893.*

GENERAL: The Board of Engineer Officers constituted by Special Orders No. 28, from Headquarters, Corps of Engineers, Washington, D. C., July 14, 1893, to consider the subject of harbor lines at Napa City, Cal., has the honor to recommend for adoption the following-described lines along the east and west banks of Napa River in the immediate vicinity of Napa City:

West side.—Beginning at a point on railroad bridge of the Southern Pacific Company at Lawrence street and distant 15 feet from east side of Water street; thence parallel to Water street to the east line of Edmonston street prolonged; thence to a point on the west side of the public landing at a distance of 130 feet east of First street; thence parallel to First street for a distance of 75 feet; thence to the northeast corner of Knapp's upper lumber wharf; thence along the front of this wharf to its southeast corner; thence to the north corner of the United States Winery (upper); thence along the brick wall and front of the wharf of this winery to the north line of Fourth street; thence to the northeast corner of Knapp's lower lumber wharf; thence along the front of this wharf to the lower end of the old portion of this wharf; thence to the upper end of the line of piling in front of Hatt's warehouses; thence along this line of piling to its lower end; thence to the northeast corner of Hatt's Wharf; thence along the face of this wharf to its lower end near Main street; thence on a line toward the most easterly point of the United States Winery (lower), until the line of the front of the Emma Landing is reached; thence along the line of that front to the lower end of the landing; thence to the upper end of the Caroline Landing (Zinfandel now); thence along that front and the front of the Hope Landing to the lower end of the latter landing; thence in the same straight line till it intersects a line parallel to the middle line of the levee and 20 feet outside of it; thence along this line until it intersects the north line of Laurel street extended.

East side.—Beginning at a point on the bridge of the Southern Pacific Company 140 feet eastward of the point of commencement of the westerly pier-head line; thence in a straight line to the intersection of the northerly line of Edmonston street prolonged, and distant 190 feet from the westerly side of Water street; thence parallel to Water street to the intersection with the southerly line of the public landing extended; thence to the westerly end of the wooden bulkhead near wagon bridge at Third street; thence along the bulkhead and the face of the east abutment of the bridge, and along the bulkhead below the bridge and continuation of that line until it intersects the line of the front of the woolen mill wharf; thence along this line to the lower end of the woolen mill wharf; thence on a line parallel to D'Hemmecourt street to a point 70 feet north of the north side of Sixth street; thence to a point on the west side of D'Hemmecourt street 40 feet north of the south side of Sixth street; thence to a point on the line of the face of the wharf of the Napa Valley Wine Company extended northerly, 50 feet from the northerly corner of wharf; thence along said line and face of wharf until it intersects the extended line of the south end of the building at Emma Landing; thence in a straight line projected toward the southerly end of the Hope Landing for a distance of 90 feet; thence in a straight line parallel to the front of the Caroline and Hope landings for a distance of 125 feet; thence parallel to Brown street until it intersects the bank of the river.

No bulkhead lines are submitted as the Board considers that no filling should be permitted beyond the lines of the natural banks.

Respectfully submitted,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.
W. H. HEUER,
Major, Corps of Engineers.
CHAS. L. POTTER,
First Lieutenant of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 17, 1893.

Respectfully submitted to the Secretary of War.

The within report of the Board of Engineers constituted by authority of the Secretary of War to consider and report upon the subject of harbor lines at Napa City, Cal., is recommended for approval.

The lines suggested by the Board are described in the within report and shown on the map* inclosed, and it is recommended that the Secretary place his approval both upon this paper and the tracing submitted.

Previous papers herewith.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *October 18, 1893.*

Approved.

DANIEL S. LAMONT,
Secretary of War.

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* Omitted.

APPENDIX T T.

IMPROVEMENT OF SAN JOAQUIN AND SACRAMENTO RIVERS AND TRIBUTARIES, AND OF RIVERS AND HARBORS IN CALIFORNIA NORTH OF SAN FRANCISCO

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. San Joaquin River, California.
2. Mokelumne River, California.
3. Sacramento and Feather rivers, California.
4. Petaluma Creek, California.
5. Humboldt Harbor and Bay, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 5, 1894.

GENERAL: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1894.

* * * * * * *

Very respectfully, your obedient servant,

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

T T 1.

IMPROVEMENT OF SAN JOAQUIN RIVER, CALIFORNIA.

Description.—The San Joaquin River flows in a general northwesterly direction from Firebaugh to its mouth. It empties into Suisun Bay, near the mouth of the Sacramento. During its high-water stage the river is navigable for light-draft boats to Hills Ferry nearly 100 miles above Stockton, and sometimes even to Firebaugh, nearly 100 miles farther; but during this period of high water there is but little freight available for boats, while during low-water periods there is not enough water in the upper river for navigation purposes. The lower river is practically an estuary.

Original condition.—Before improvement the low-water channel to Stockton was only about 6 feet in depth, while the upper river, above Stockton, was navigable to Hills Ferry for but few months in the year, during the high-water stage, and then only for boats drawing 2 feet of water or less.

Work prior to June 30, 1893.—The project for the improvement was adopted in 1877, and slightly modified in 1881 and 1888. Its object is to secure and maintain, by dredging, a channel 9 feet deep at low water and 100 feet wide through the tidal portions of the river and Stockton Slough to Stockton, and a channel 4 feet deep at low water and 100 feet wide to Miller's warehouse, in Mormon Slough; to secure the temporary improvement of the low-water channel by dredging, scraping, and small wing dams, and to effect the closure or partial closure of Paradise Cut and Laird Slough.

Up to 1887 all the work on this river was done by contract, and the cost of dredging varied from 45 to 15 cents per cubic yard. In 1887 a dredge was built by the Government, and since that time the cost has averaged less than 10 cents per cubic yard.

In December, 1888, a dam for the partial closure of Paradise Cut was completed. During the excessive floods of 1890 this dam was injured beyond repair, and was accordingly rebuilt in the fall of 1891.

A dam was constructed across Laird Slough during August and September, 1891. Owing to damage by floods it became necessary to rebuild it in part in the fall of 1892.

Paradise Cut Dam was again repaired in 1892.

Dredging has been in progress each year, and the river has also been straightened by several cut-offs with great benefit to navigation. Wherever cut-offs have been made they have been self-maintaining.

Amount expended and results obtained to June 30, 1893.—The amount expended on the San Joaquin River up to June 30, 1893, was $280,705.85. The constant work of improvement had given and maintained a low-water channel of 9 feet to Stockton, and rendered steamboating to that city comparatively easy and safe all the year round.

While the upper river had been improved by the partial closure of Paradise Flat and Laird Slough the annual time of navigation was not materially lengthened.

APPROPRIATIONS.

August 14, 1876	$20,000	August 11, 1888	$25,000
June 14, 1880	20,000	September 19, 1890	75,000
March 3, 1881	40,000	July 13, 1892	65,000
August 2, 1882	40,000		
July 5, 1884	20,000	Total	323,750
August 5, 1886	18,750		

Report of operations during the past fiscal year.—In September, 1893, the San Joaquin River had fallen so as to render dredging again necessary, the United States dredge was accordingly put to work on September 18 at Wakefield Landing, about 5 miles below Stockton, where a bad sand bar had formed. This was removed to a depth of 9 feet below low water, which necessitated the excavation of 22,842 cubic yards of material. The dredge was then moved to a hardpan bar nearly opposite Raggi Landing. This bar became an obstacle to navigation by reason of the new double cut-off at the narrows, causing boats to take a different course to the one formerly used. It also was removed to a depth of 9 feet below low water, requiring the excavation of 4,110 cubic yards of material, all hardpan. After this was done the dredge was removed into Stockton Slough, where work was carried on until the end of December when, the channel being in a fair condition and the funds practically exhausted, the dredge was laid up near Stockton. In Stockton Slough the dredge made cuts aggregating 3,585 feet in length, 50 feet wide, to a depth of 9 feet below low water, to do which 32,964 cubic yards of material were excavated and placed on shore. The dredge was at work altogether during this season for one hundred and five days, and removed and placed on shore an aggregate of 59,916 cubic yards of material. The total cost of the dredging was $4,771.57, or 7.9 cents per cubic yard. Much delay was caused by repairs which became necessary to the dredge during the work, and it is probable that it will have to be extensively repaired before work is again resumed.

On July 5, 1893, bids were opened for dredging a double cut-off in the San Joaquin River, below Stockton. The following bids were received:

	Cents per cubic yard.
(1) John Hackett, San Francisco, Cal	15
(2) Ferris & Williams, San Francisco, Cal	18

On July 23, 1893, a contract was entered into with John Hackett. He began work on August 12, and completed the cut-off on September 11. There were 110,093 cubic yards of material, consisting of peat and clay, excavated and placed on shore behind levees. The cut is 1,900 feet in length and 150 feet in width. The bottom of the cut is horizontal and 9 feet below mean low tide. The average width of the river in the vicinity is 175 feet. Besides avoiding two sharp bends three-tenths of a mile is saved to vessels by the cut.

On September 4, 1893, bids were opened for making a double cut-off at Twenty-one Mile Slough, San Joaquin River. The following bids were received:

No.	Name and address of bidder.	Price per cubic yard.	Amount for 200,000 cubic yards.
		Cents.	
1	San Francisco Bridge Company, San Francisco	8.74	$17,480
2	John W. Ferris, San Francisco	11	22,000
3	John Hackett, San Francisco	10	20,000

On September 14, 1893, a contract was entered into with the San Francisco Bridge Company. The contractors began work on September 16, and completed the cut-off satisfactorily on October 17. The material excavated, amounting to 204,422 cubic yards, and consisting of peat and mud, was deposited behind levees along the bank, 50 feet back from the edges of the cut. The cut is 100 feet in width at bottom, with slopes averaging 1 on 1. The bottom is horizontal, and 9 feet below the level of mean low water. The east portion of the cut is 1,250 feet long, and the west portion 2,525 feet. The average width of the river in the vicinity is 300 feet, with a considerably larger cross-sectional area than that of the cut. The size of the cut would have been increased had funds permitted. Vessels began to pass through the cut as soon as completed, thus avoiding two sharp bends in the river, and shortening their route by 1.4 miles.

A bridge over the San Joaquin River at Garwood Ferry was completed during the year. It is not an obstruction to navigation.

Amount expended and results obtained during the past fiscal year.—The amount expended on the San Joaquin River during the past fiscal year was $40,554.59, making the total amount thus far expended $321,260. A low-water channel of 9 feet to Stockton has been maintained, and navigation has been rendered easier by the cut-offs made.

Future operations.—When funds permit, the cut-off previously made at Head Reach could be increased in width and depth with advantage to navigation. The estimated cost of this is $37,350. There is an obstruction to navigation near the county bridge just above the entrance to Stockton Channel, formed by an old corduroy road built to a ferry which was abandoned when the county bridge was built. This forms a serious sand bar, and makes it extremely difficult for boats to pass. It can be removed at an estimated cost of $5,000. Annual dredging will be necessary to keep Stockton Slough in a navigable condition; in fact, without it steamboats would be unable to reach Stockton.

With any future appropriations, depending on the amount and the requirements of commerce, it is proposed to continue work in the following order, unless Congress should otherwise direct:

1. Dredging to maintain 9 feet depth to Stockton	$35,000
2. Increasing cut-off at Head Reach, in width, depth, or both	37,750
3. Removing obstruction near county bridge above Stockton Slough	5,000
4. Increasing cut-off at Twenty-one Mile Slough in width, depth, or both	20,000
5. Snagging, wing-dams, etc	10,000
Total	107,750

All of the above amounts can be advantageously expended in one fiscal year.

Remarks.—The trade between San Francisco and Stockton is very important. There are two regular lines of steamers running steamboats every week day between the two cities. The commerce of the river is now carried on 12 steamboats of from 98 to 880 tons and drawing from 1.5 to 7 feet of water, and on 14 barges of from 160 to 660 tons, averaging 300 tons.

While it can not be asserted that the improvements made have caused any reduction in freight or insurance rates, it is almost certain that if they were not continued there would soon be a material increase.

Money statement.

July 1, 1893, balance unexpended	$43,044.15
June 30, 1894, amount expended during fiscal year	40,554.59
July 1, 1894, balance unexpended	2,489.56
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1896	107,750.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

STATISTICS OF TRADE.

The following statement of the freight carried on the San Joaquin River by the boats and barges of the California Navigation and Improvement Company was furnished by Capt. Corcoran, the manager of the company:

On the upper river, above Stockton.

	Tons.
Down-river freight:	
Wool	188
Cord-wood	1,500
Wheat	18,900
Total	20,588
Up-river freight, miscellaneous	3,000

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* Indeterminate.

The following freight, which is the amount carried on the Tuolumne River during the past year, passes over the Upper San Joaquin River to reach the Tuolumne. It is therefore given:

	Tons.
Down river freight, wheat	1,849
Up river freight, miscellaneous	2,500
Total	4,349

The following freight was carried on the river between Stockton and San Francisco Bay:

	Tons.
Wheat	79,400
Lumber	19,200
Coal	20,500
Mill stuffs	65,000
Wool, wine, paper, and manufactured products	53,000
Produce	14,000
Pulp, hides, and other raw materials	13,000
Total	264,100

Passengers, 103,000.

The following freight was carried on the river by the steamer *Ellen*, Capt. A. F. Williams, owner:

	Tons.
Grain	8,130
Lumber, coal, and cord wood	5,420
Miscellaneous freight	5,007
Total	18,557

The following statement of the freight carried on the San Joaquin River by the boats of the Union Transportation Company was furnished by Capt. C. M. Keniston, the secretary of the company. These boats only run between Stockton and San Francisco, calling at way landings:

	Tons.
General merchandise	18,000
Flour and mill stuffs	10,000
Grain	3,000
Coal	3,000
Produce	1,500
Total	35,500

Passengers, 51,509.

Which makes a total for this river (as reported by the carriers): Freight, 346,094 tons; passengers, 154,509.

T T 2.

IMPROVEMENT OF MOKELUMNE RIVER, CALIFORNIA.

Description.—The Mokelumne River is a tributary of the San Joaquin, which it enters about 20 miles above the mouth of the latter. In the lower part of its course it is subject to tidal influence and is always navigable to New Hope Landing. Although, in seasons of high water, boats go a few miles farther upstream, New Hope Landing is practically the head of navigation. At this point the channel separates into the north and south forks, which unite again about 4 miles before reaching the San Joaquin. The length of the north fork is 9 miles and of the south fork 14 miles.

Original condition.—Before improvement navigation on this river was dangerous and difficult, on account of numerous snags and overhanging trees.

Work prior to June 30, 1893.—A project for the improvement of this river was made in 1884, having for its object the removal of the trees and snags obstructing navigation. Both forks of the river were cleaned out in 1884, 1885, 1886, 1887, and 1888, rendering steamboating to the head of navigation easy and safe. This completed the project as outlined, and since then no work of improvement has been done on the river.

Amount expended and results obtained to June 30, 1893.—The amount expended on this river up to June 30, 1893, was $12,480.70. Results previously obtained were not permanent. Since 1888 snags have reformed, trees regrown, and the channel again requires cleaning. Another obstruction is a point of land jutting out into the channel near New Hope Landing This landing, at the junction of the two forks, is the most important one on the river. The south fork, which is bridged at this point, is hardly navigable for 1½ miles below. The river proper and the north fork make a junction which is nearly a right angle. The point of land referred to being a tongue between the river and the north fork is constantly extending into the fork, increasing the curvature of the bend, and, in consequence of the current, making it very difficult for a boat to get to the landing at New Hope.

APPROPRIATIONS.

July 5, 1884	$8,500
August 5, 1886	2,500
August 11, 1888	2,000
July 13, 1892	2,500
Total	15,500

Amount expended and results obtained during the past fiscal year.—No work was done, no money was expended, and no further results obtained.

Future operations.—To make the above-described landing easy and safe and give a more direct entrance for the river into the north fork, the point referred to, which contains about two-thirds of an acre, should be removed to a depth of 6 feet below low water.

The estimated cost of this improvement is as follows:

Removing snags and overhanging trees	$3,000
Removing sand bar caused by canal, 50,000 cubic yards, at 10 cents per yard.	5,000
Cutting off point near New Hope Landing, including grubbing and purchase of land	1,100
Total	9,100

All of the above work could be advantageously done in one fiscal year.

The act of July 13, 1892, appropriating $2,500 for the improvement of this river, contained a proviso that no part of the amount should be expended until the drainage canal cut by private parties near New Hope Landing was closed. This has at last been done, and when the stage of water permits work can be resumed.

Remarks.—The statistics of trade furnished by the California Transportation Company for the year from June 1, 1893, to May 31, 1894, are as follows:

Freight	tons..	38,812
Passengers		3,059

This commerce is carried on one stern-wheel steamer, the *Constance* (385 tons, draft light 2.5 feet, loaded 6 feet), which makes one to three round trips per week.

The steamer *Ellen* (91 tons), which makes occasional trips into this river, furnishes the following statistics for the year from June 1, 1893, to May 31, 1894:

	Tons.		Tons.
Potatoes	364	Live stock	35
Hay	614	Cord wood	80
Wheat and barley	2,176		
Lumber	430	Total	3,699

While it can not be asserted that the improvements have caused any reduction in the rates of freight or insurance, it is certain that the maintenance of navigation on this river is of the greatest benefit to the neighboring community. The rate of freight by the river is $1 per ton less than by railway from competing points, so on the above freight there is a saving to the shippers of this district in one year of over $42,000.

Money statement.

July 1, 1893, balance unexpended	$3,019.30
July 1, 1894, balance unexpended	3,019.30
Amount (estimated) required for completion of existing project.	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1896	9,100.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

T T 3.

IMPROVEMENT OF SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

Description.—The Sacramento River is a navigable stream as far as Red Bluff, about 275 miles above its mouth. For twenty years, however, after the railroads were put in operation, boats did not find it commercially profitable to go above McIntosh Landing, about 45 miles below. In 1892 they went as far as Tehama, about 16 miles below Red Bluff.

The Feather River is a tributary of the Sacramento, entering it about 16 miles above the city of Sacramento. It is a navigable stream for about 30 miles above its mouth to its junction with the Yuba River at the town of Marysville.

Original condition.—Before improvement was begun navigation was difficult on account of numerous bad snags, shallow bars, and rapids, but the exorbitant rates that could be charged for freight and passage, owing to there being no competition, made steamboating profitable.

Work prior to June 30, 1893.—In 1874, a project was made and approved for the improvement of both rivers. It had for its object the temporary improvement of the low-water channels by removing snags, scraping bars, and building wing dams. Work has been continuous on this project ever since whenever funds permitted.

The river and harbor act of September, 1890, provided for a Board of Engineers to examine and report on the Sacramento and Feather rivers with a view to their future improvement. In their report (see Annual Report of the Chief of Engineers, 1891, p. 2990) the following appropriations are recommended:

(1) A specific yearly appropriation of $25,000 for snagging, building wing dams, etc., above the city of Sacramento.

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* Indeterminate.

(2) A specific appropriation of $275,000 for removal of obstructions in the Lower Sacramento River, and $25,000 for the closure of Jacob Slough.

(3) A specific appropriation of $300,000 for the treatment of the Yube River near and above Marysville.

(4) A specific annual appropriation of $20,000 for improving the navigable channel of the Feather River.

In 1892 the project was modified and increased to include the closure of Jacob Slough, a large crevasse above the city of Sacramento, the maintenance of navigation on the Feather River by means of wing dams to remove shoals, and the treatment of the Yuba River near and above Marysville.

In 1892 snags were removed and the channel of the Upper Sacramento put in good condition from the mouth of the river to Tehama. A survey of Jacob Slough, a crevasse in the left bank of the Sacramento River about 12 miles above the city of Sacramento, was made in November, 1892, and a plan for its closure made and approved. The work was, however, delayed until the next fiscal year, as it could only be done economically at the low stage of the river.

A survey of the junction of the Yuba and Feather rivers was made and a plan prepared and approved for cutting a new channel for the mouth of the Yuba, and thus secure a more harmonious confluence of the two rivers. Work on this plan was not begun until the next fiscal year.

The flood stage in 1892 was far above that of average years and of unusually long duration. There were numerous breaks in the levees in consequence, which caused heavy losses to the farmers, but did not materially injure navigation.

Amount expended and results obtained to June 30, 1893.—The amount expended on the Sacramento and Feather rivers to June 30, 1893, was $504,537.48. The snagging previously done was of great benefit to navigation; without it, in fact, steamboating in the Upper Sacramento would not have been possible. Boats in 1892 went as far as Tehama, 16 miles below Red Bluff. Freight and insurance rates were greatly reduced.

APPROPRIATIONS.

March 3, 1875	$15,000	July 5, 1884	$40,000
June 18, 1878	15,000	August 11, 1888	20,000
March 3, 1879	20,000	September 19, 1890	30,000
June 14, 1880	45,000	July 13, 1892	150,000
March 3, 1881	60,000		
August 2, 1882	250,000	Total	645,000

Report of operations during the past fiscal year.—The Sacramento River having reached a comparatively low stage, the snag boat *Seizer* started on July 12, 1893, up the river. Tehama was reached on August 26, and the task of opening the river to Red Bluff was begun. This was accomplished by September 13, on which day the snag boat arrived at Red Bluff, being the second steamboat to visit that town in over twenty years. A railroad bridge, built without a draw, crosses the river at Red Bluff. The snag boat then descended the stream, reaching Sacramento on October 23, 1893. It was then taken to the lower river for a few days' work, and on October 28 was put out of commission and laid up at Sacramento. During the season's work on the upper river, which lasted one hundred and three days, the boat ran 1,493 miles, removed 939 snags and 4 trees, fired 131 blasts, using 841 pounds of giant powder, and built 270 linear feet of wing dams. During 5 days' work on the lower river, 98 miles were run, 22 snags removed, 6 blasts fired, and 62 pounds of giant powder used. The total cost of the work, which was of the greatest benefit to navigation, was $12,896.21.

The snagging during the fiscal year was under the charge of Assistant Engineer H. L. Demeritt, civil engineer, and the work has been well done and very satisfactory.

At the end of the fiscal year, the water having again fallen, the snag boat was put in commission and sent to the Upper Sacramento River.

Contract for closing Jacob Slough, bids for which were opened on June 20 of the last fiscal year, was entered into with Robert Tibbitts on July 8, 1893. A levee was built 2,690 feet long, 15 feet wide on the top, with slopes of 1 on 3 on the river side and 1 on 2 on the opposite side, the top being 4 feet above high water. This levee was built around the crevasse, and was joined to the ends of the old broken levee. A little over 1,200 feet of the new levee was protected on the river side by a pile and brush revetment formed by two rows of piles filled in with brush, the rows being 5 feet apart and the piles in each row 10 feet apart. The river slope of the remainder of the levee, about 1,400 feet, is revetted with a brush mattress about 1 foot in thickness. The completed work contained 6,606 linear feet of piles, or 240 piles, 25,266 cubic yards of earth, 3,053 cubic yards of brush placed between the piles, and 1,150 cubic yards of brush used in revetment. The total cost of the work was $10,732.99.

Bids for making a new mouth for the Yuba River at its confluence with the Feather were opened on August 15, 1893. The following were received:

California Construction Company, San Francisco, Cal.:	
236,000 cubic yards of excavation, at 17¾ cents	$41,890
2,500 cubic yards of mattresses, at $1	2,500
1,000 tons of rock, at $3.40	3,400
Total	47,790
William Elliott, Marysville, Cal.:	
236,000 cubic yards of excavation, at 17½ cents	41,300
2,500 cubic yards of mattresses	2,500
1,000 tons of rock, at $6	6,000
Total	49,800
Joseph E. Smith, Portland, Oreg.:	
236,000 cubic yards of excavation, at 19½ cents	46,020
2,500 cubic yards of mattresses, at 56 cents	1,400
1,000 tons of rock, at $3.75	3,750
Total	51,170
Jared Cook Frasier, Grand Island, Cal.:	
236,000 cubic yards of excavation, at 24¾ cents	58,410
2,500 cubic yards of mattresses, at $1	2,500
1,000 tons of rock, at $4	4,000
Total	64,910
California Bridge and Construction Company, San Francisco, Cal.:	
236,000 cubic yards of excavation, at 39 cents	92,040
2,500 cubic yards of mattresses, at $1.95	4,875
1,000 tons of rock, at $2	2,000
Total	98,915

The bid of the California Construction Company was accepted, and contract entered into with them on August 22, 1893. They commenced work at once, the river being at a low and favorable stage, pushed it vigorously, and completed it on November 20, 1893. The cut is about 2,500 feet in length, 50 feet in width on the bottom, and 350 feet in width on the top, with sloping sides. Longitudinally the bottom of the cut was made to slope from a point 2 feet below low-water level on the Yuba River to a point 2 feet below low-water level on the Feather River, which amounted to a total fall of 6.5 feet, equivalent to a little over 3 inches to 100 feet. Within a few days after the cut was completed a scour of 1 foot 2 inches had taken place. In making the cut 238,990 cubic yards of earth were excavated, 2,163 cubic yards of brush mattress, and 46$\frac{1}{5}$ tons of rock used in revetment of the banks. The total cost was $45,294.75.

Surveys and borings were made in the bed of the Yuba River above Marysville to enable plans for additional improvements to be made as they become necessary.

Surveys were also made in the Sacramento River at various shoal places between its mouth and the city of Sacramento to furnish data for the location of wing dams. Such a marked improvement was shown that, with the single exception of Heacock Shoals, 10 miles below the city of Sacramento, no wing dams will be required to obtain the desired depth at low water.

Amount expended and results obtained during the past fiscal year.—The amount expended on the Sacramento and Feather rivers during the past fiscal year was $73,777.44, making the total amount thus far expended $578,314.92.

The snagging has been of the greatest benefit to navigation. The river is now in good navigable condition to Red Bluff, the head of navigation.

The cut made to provide a new mouth for the Yuba River has been successful, not only in making a more harmonious confluence of the Feather and Yuba rivers, but also as a relief in carrying off the flood waters of the latter stream.

Surveys on the Sacramento River showed a marked improvement; there is now no impediment to navigation except at Heacock Shoals.

Remarks.—The commerce of the Sacramento River is carried on 8 steamers, 16 grain barges, and 7 brick barges belonging to the Sacramento Transportation Company; 5 steamers and 7 barges belonging to the California Transportation Company, and 2 steamers belonging to the Southern Pacific Company. The steamers vary in size from 183 to 619 tons, averaging 303 tons, and the barges from 118 to 800 tons, averaging 600 tons. The larger of the steamers only go a short distance up the river, the commerce of the upper river being carried on barges towed by light-draft steamboats.

On the Feather River a small steamer, 247 tons gross tonnage, belonging to the Southern Pacific Company, makes one round trip per week with a barge, and carries all the freight that offers.

Future operations.—The recommendations of the Board of Engineers of 1890 have been carried out as far as the closing of Jacob Slough is concerned, and the formation of a new mouth for the Yuba River. Snagging and the building of wing dams have been carried on each year by means of the United States snag boat *Seizer*. This work it is proposed to continue, and wing dams will probably be built at Heacock Shoals during the next fiscal year at the low stage of the river. Of the amounts recommended by the Board, the whole of items 1 and 4, $5,000 of item 2, and $5,000 of item 3 can be advantageously expended in the fiscal year ending June 30, 1896.

Money statement.

July 1, 1893, balance unexpended	$140,462.52
June 30, 1894, amount expended during fiscal year	73,777.44
July 1, 1894, balance unexpended	66,685.08
July 1, 1894, outstanding liabilities	1,500.00
July 1, 1894, balance available	65,185.08
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1896	55,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

STATISTICS OF TRADE.

The following statistics were kindly furnished by the auditor of the Southern Pacific Company for their boats plying between San Francisco and Sacramento, Cal.:

	Tons.
North bound	50,107
South bound	30,322
Total	80,429

The California Transportation Company make the following statement of the freight carried by their boats between San Francisco and points on the Sacramento River below Sacramento:

	Tons.
Merchandise, fruit, produce, grain, and coal	78,592
Lumber	9,000
Total	87,592

Passengers, 13,000.

The owners of the steamer *Ellen* make the following statement:

	Tons.		Tons.
Grain	1,161	Wood	1,244
Merchandise	290	Lumber	1,221
Hay	700		
Horses	104	Total	4,720

The following statement of the freight carried on the Sacramento River by the boats and barges of the Sacramento Transportation Company, during the year from June 1, 1893, to June 1, 1894, was furnished by Capt. J. H. Roberts, president of the company:

	Tons.		Tons.
Coal	10,409	Produce	4,500
Lumber	23,750	Wool	450
Brick	33,000	Live stock	800
Merchandise	34,218		
Wheat	66,946	Total	185,273
Cord wood	11,200		

There is included in the above, 6,144 tons of wheat, which is the amount reported as brought from McIntosh Landing and points above during the year, and 709 tons of merchandise, which is the amount reported as taken to points above McIntosh Landing during the same period.

The total tonnage of the Sacramento River, as reported by the transportation companies, is 358,014 tons.

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*Indeterminate.

The Southern Pacific Company also makes the following statement of freight carried on its boat from Sacramento to Marysville over the Feather River:

	Tons.
North	7,845
South	10,951
Total	18,796

T T 4.

IMPROVEMENT OF PETALUMA CREEK, CALIFORNIA.

Description.—Petaluma Creek, which is really an estuary, extends from San Pablo Bay to the town of Petaluma, about 16 miles, and is the outlet for a large amount of freight from a rich agricultural district.

Original condition.—Before improvement the channel was very crooked and, in places, dry at low water, making navigation difficult and uncertain.

Work prior to June 30, 1893.—In 1880 a project for its improvement was adopted, which had for its object to obtain by dredging a channel 50 feet wide and 3 feet deep at low water, and to straighten it by cut-offs. Contracts were let for this purpose, and work carried on in 1880, 1881, 1882, and 1884, when the project was completed by the removal of 89,692 cubic yards of material at a cost of $27,656.91. As the creek receives the drainage of a highly cultivated region of considerable area, the channel is constantly refilling. In 1888 the channel was again dredged to a width of 40 feet and depth of 1 foot below low water. This cost $2,116.30, and partially relieved the immediate wants of navigation. The channel again filled up and, when funds became available in 1891, a contract was let to redredge it. This resulted in a channel 6,800 feet long by 40 to 45 feet wide, with a depth of from 3 feet to 30 inches below low water. This time 37,005 cubic yards of material were excavated at a cost of $5,846.36. As this exhausted the available funds, work was then stopped. In 1892, another appropriation having been made, the creek was surveyed and a project submitted for its improvement. This project, which contemplated the excavation of a channel 50 feet wide and as long and deep as funds would permit, was approved, and work under it commenced on May 2, 1893, near Haystack Landing, about 3 miles below the town of Petaluma. Work was prosecuted upstream, and at the end of the fiscal year, 37,171 cubic yards of material had been excavated and pumped on shore at a cost of $4,184.03, or 11.2 cents per cubic yard.

Amount expended and results obtained to June 30, 1893.—The amount expended on Petaluma Creek, up to June 30, 1893, was $41,287.93. At the end of the fiscal year a channel 5,107 feet long, 50 feet wide, and 3 to 4 feet deep had been completed.

APPROPRIATIONS.

June 14, 1880	$8,000	September 19, 1890	$4,000
March 3, 1881	8,000	July 13, 1892	10,000
August 2, 1882	14,000		
August 11, 1888	2,000	Total	46,000

Report of operations during the fiscal year.—At the beginning of the fiscal year dredging was in progress, and was continued until September 10, 1893, when the funds were exhausted. By this time 50,864 cubic yards of material had been excavated and placed on shore by the U. S. Government dredge. The total number of cubic yards of material excavated to dredge the channel from Haystack Landing to Petaluma was 88,035, which was done at a cost of 9.9 cents per cubic yard (including all office, engineering, and contingent expenses). A considerable amount of the material excavated was hardpan, and near the town of Petaluma a large quantity of paving blocks were met with, which occasioned great delay and considerably increased the expense.

Amount expended and results obtained during the past fiscal year.—The amount expended during the past fiscal year was $4,570.12, making the total amount thus far expended $45,858.05. During the past fiscal year the length of channel dredged was 5,973 feet; this was dug 50 feet wide and to a depth of 3 or 4 feet below low water. The channel now reaches the town of Petaluma, and is of the greatest benefit to commerce.

Remarks.—The commerce of Petaluma Creek is carried on one steamer, the *Gold*, 294 tons, which makes six round trips per week, also on numerous small schooners, which carry the heavier freight.

The commerce of a large, flourishing, and constantly increasing agricultural community, as well as of several manufacturing industries, is carried on this creek, which considerably influences railroad freight rates, not only from points actually on the creek, but also from all points within hauling distance.

The commerce is large, important, and increasing, as shown by the statistics herewith, and to properly accommodate it a channel should be dredged, with a depth of 5 feet at low water, to the head of navigation. This would require the removal of 214,173 cubic yards of material, much of which is hardpan. The estimated cost of this is $53,543. It could be done in one fiscal year. As this channel is not self-maintaining, dredging, at an estimated cost of $4,000, would be required about once in every two years.

Money statement.

July 1, 1893, balance unexpended	$4,712.07
June 30, 1894, amount expended during fiscal year	4,570.12
July 1, 1894, balance unexpended	141.95

Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1896	53,543.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

STATISTICS OF TRADE.

The following statistics of the trade on Petaluma Creek during the year ending May 31, 1894, were collected by a committee appointed by the board of trustees of the town of Petaluma for the purpose. The report was compiled by them from information furnished by owners and agents of vessels doing business on the creek, and by the principal merchants, manufacturers, and business houses in the town:

Commodity.	Tons.	Value.	Commodity.	Tons.	Value.
General merchandise	16,500	$8,250,000	Mill stuff	10,900	$279,500
Grain	26,860	516,960	Live stock	2,656	218,260
Coal	1,845	10,605	Agricultural products	26,593	855,212
Building material	2,288	28,764	Cannery products	50	10,000
Lumber	7,315	173,364	Miscellaneous	12,500	781,665
Wool and woolen goods	1,540	308,000			
Wood and tan bark	987	3,825	Total	110,034	11,442,145

Number of passengers, 12,126; fare paid, $6,063.

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* Indeterminate.

T T 5.

IMPROVEMENT OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

Description.—Humboldt Bay, which is 230 miles north of San Francisco, in latitude 40° 46′, is an estuary about 14 miles in length, with its largest dimension parallel to the ocean. It is separated from the sea by two narrow tongues of land, which extend to high land both on the north and south, and between which lies the channel which communicates with the sea. The high-water area of the bay is about 24 square miles, and the low-water area about 13 square miles. The mean rise and fall of the tide is 4.4 feet, becoming 8 feet or more at springs, and less than 3 feet at neaps. The average tidal discharge per second is about 100,000 cubic feet. Humboldt Bay is the only inclosed harbor in California north of San Francisco, and is the most important lumber port in the State.

Original condition.—Before improvement, entrance to the harbor was obstructed by a bar, the channel through which was variable in position (from southwest to north-northwest, 1½ miles apart at the sea ends), variable in depth (from 9 feet to 25 feet), and variable in width (from 2,200 feet to 4,200 feet). There were also numerous shoals in the harbor, rendering it difficult for vessels to reach Eureka, Arcata, and Hookton.

Work prior to June 30, 1893.—In 1881 a project was adopted with the object of securing a channel 13 feet deep and 200 feet wide to the head of Eureka wharves, and one 10 feet deep and 100 feet wide to Arcata and Hookton. This portion of the project was completed in 1884, at a cost of $96,061.55. These channels have since silted up somewhat, but not sufficiently to seriously impede commerce.

In 1882 an additional project was adopted with the view of increasing the depth over the bar at the entrance to the harbor. This was to be done by constructing a low-tide stone jetty, extending seaward from the south spit for a distance of 6,000 feet. The estimated cost of this was $600,000. As the money appropriated was not available until certain land required was obtained free of expense to the Government, nothing could be done until 1888, when a contract was let under the above project. Operations were begun in 1889, and carried on until October, 1890, when the contractor failed. Under this contract the south jetty was built out 2,767 feet, 900 feet of this length being raised to high-water level.

In October, 1890, a Board of Engineers recommended two high-tide stone and brush jetties, starting from the north and south spits respectively, and extending seaward to the 18-foot contour. The north jetty was not to be begun until the completion of the south. The estimated cost of the two jetties was $1,957,615.

This project was adopted, and in May, 1891, work was begun under another contract and continued until December, 1891. Under this contract 300 linear feet of brush mattress and stone protection work was built to arrest erosion of the north spit, the north jetty was carried out to a distance of 1,480 feet, and the south jetty was extended 600 feet, making it 3,699 feet long. This completed the contract.

Owing to insufficient funds no work was done from December, 1891, to April, 1893.

On account of the continued erosion of the north spit the project was again slightly modified in 1892, as suggested by a Board of Engineers, so as to make the previously built dike part of the jetty. The north jetty was relocated, and its construction authorized out to a point sufficient to arrest erosion, without waiting for the completion of the south jetty.

Funds having been appropriated by the river and harbor act of July 13, 1892, and the improvement placed under the so-called continuous contract system, proposals for the work were invited. On December 16, 1892, a contract was entered into with John C. Bull, jr., the lowest bidder. After completing his preparations he began work on the north spit in accordance with the latest project, delivering the first load of stone on April 14, 1893. By the end of the fiscal year the work done amounted to 832 feet of trestle, 4,779 cubic yards of brush mattresses, and 14,224 tons of rock. This made the north jetty 2,293 feet long. Nothing was done on the south jetty.

The total amount earned by the contractor up to June 30, 1893, was $39,896.60.

Amount expended and results obtained to June 30, 1893.—The amount expended on jetty work up to June 30, 1893, was $338,893.31. Owing to the incomplete condition of the jetties, no conspicuous improvement had occurred in the depths over the bar; a channel 18 feet in depth had been maintained, however, and no vessels were delayed on account of insufficient depth of water. The old inside channel, close to the north shore protection work, remained practically closed to navigation. The Bucksport Channel, which had opened while the other was closing, showed a least depth of 9 feet of water. A large quantity of sand had been arrested by the south jetty, roughly estimated at upward of 2,000,000 cubic yards.

APPROPRIATIONS.

March 3, 1891	$40,000	September 19, 1890	$80,000
August 2, 1882	40,000	July 13, 1892	150,000
July 5, 1884	62,500	March 3, 1893	522,000
August 5, 1886	75,000		
August 11, 1888	125,000	Total	1,094,500

Report of operations during the past fiscal year.—At the beginning of the fiscal year, July 1, 1893, work was in progress under the contract of December 16, 1892, with John C. Bull, jr.; Mr. D. E. Hughes, assistant engineer, being in local charge. Lieut. Herbert Deakyne, Corps of Engineers, assumed local charge August 3, Mr. Hughes being retained under his orders.

North jetty.—The contractor's progress was not satisfactory, the monthly delivery of rock for July, August, and September falling considerably short of the specifications. On August 10 the pile-driving temporarily ceased, in order that the completed jetty, which was about 1,600 feet behind the pile driver, could be pushed to within about 600 feet of the end of the trestle.

Evidences of scour beginning to appear in the vicinity of bent 100, a mattress and rock spur was built in the vicinity of bent 92 during August to deflect the ebb current. This spur had to be built up again in January, 1894. Its total cost was about $550.

Pile-driving was resumed on October 2, the completed jetty having been brought to within 640 feet of the end of the trestle.

In October a crossover on the trestle between the two tracks was built at a cost of $250.75. It was a great convenience in hauling rock.

By a storm on November 24 the contractor lost 6 bents of trestle, a mattress containing 150 cubic yards of brush, part of a pile-driver, and some minor articles. This accident left 5 bents separated from the rest of the trestle by a gap of 112 feet. They stood without damage until the gap had been repaired. One additional bent was then driven, when pile-driving stopped and the work was confined to completing the jetty to bent 225. The bents are 16 feet apart and numbered consecutively. All work ceased on February 2, 1894, and was not resumed until the latter part of April. From that time until the end of the fiscal year the regular work of jetty extension was carried on without intermission. During June a crossover between the two tracks was constructed. By the end of the fiscal year piles had been driven to bent 323, a length of 5,178 feet; mattress work had been extended about 8 feet beyond bent 311, a length of 4,993 feet; the trestle had been completed to bent 311, and the completed jetty extended to bent 235.

During the fiscal year the work done on the north jetty amounted to 2,674 feet of trestle, 14,343 cubic yards of brush mattresses, and 72,483 tons of rock. The north jetty is now 5,178 feet long, and completed for a length of 3,767 feet.

South jetty.—From soundings during the summer near the south jetty it was learned that the channel was encroaching on the jetty. To stop this it was decided to build spurs. The first spur was built August 18, 1893, opposite bent 80. Spurs of brush and rock were also built at bents 100, 120, 135, and 150. They averaged about 36 by 25 feet in plan, the longer dimension perpendicular to the jetty, and 3.3 feet in thickness. At bents 165 and 190, spurs were built of rock alone. These spurs cost from $500 to $900 each. Beyond the construction of spurs, no other work was done on the south jetty during the season of 1893, except filling up some gaps and some preparatory work.

During December, 1893, 11 bents, consisting of piles and trackway, were lost owing to storms, making a total of 22 bents lost on this jetty.

During May and June 15,836 tons of rock were placed in the south jetty, being used to revet a portion of the slope on the channel side. The revetment was completed to bent 184.

During the fiscal year the work done on the south jetty amounted to 555.23 cubic yards of brush and 19,758 tons of rock. The south jetty is now 3,699 feet long.

The total amount earned by the contractor during the fiscal year is $179,251.04.

For further detailed information I refer to the appended report of Lieut. Herbert Deakyne, Corps of Engineers.

Amount expended and results obtained during the past fiscal year.—The amount expended during the fiscal year ending June 30, 1894, was $162,725.18, making the total amount thus far expended $576,483.59.

Three surveys of the entrance were made during the fiscal year, one completed in August, 1893, one in December, 1893, and one in May, 1894. The last survey showed a channel over the bar 24 feet deep, with a least width of 950 feet.

No vessels were prevented from crossing the bar on account of inadequate depth of water, though delays occasionally occurred owing to the roughness of the sea.

The effect of the spurs on the south jetty has been to cause a continuous sand bank to accumulate on the channel face of the jetty out to bent 150. A large amount of sand was impounded on the north side of the north jetty.

Future operations.—The amount of money at present available for the work is $517,386.41. The existing contract requires that $475,000 worth of work be completed by the end of the present working season, of this $219,130 has been earned up to the end of this fiscal year.

In addition to the amounts already appropriated for this work, $225,000 can be advantageously expended during the fiscal year ending June 30, 1896.

Money statement.

July 1, 1893, balance unexpended		$680,741.59
June 30, 1894, amount expended during fiscal year		162,725.18
July 1, 1894, balance unexpended		518,016.41
July 1, 1894, outstanding liabilities	$630.00	
July 1, 1894, amount covered by uncompleted contracts	517,386.41	
		518,016.41
Amount (estimated) required for completion of existing project		1,043,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1896		225,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

REPORT OF LIEUT. HERBERT DEAKYNE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 20, 1894.

SIR: I have the honor to submit the following report of operations for the improvement of the entrance to Humboldt Bay, California, during the season beginning March, 1893, and ending February, 1894.

At the beginning of the season the south jetty had been extended to bent 230, a length of 3,699 feet. The trestle of this jetty was all standing, and had suffered no injuries of any importance. On the north side of the entrance a dike had been built out in a southerly direction for 92 bents, a length of 1,480.5 feet. There were a number of piles broken out in various places along this dike. A part of the shore track on the North Spit had been carried away.

The work in contemplation was the extension of the south jetty to the bar and the construction of a jetty on the north side, starting from the outer end of the dike and extending to the bar. During the season of 1893 it was intended to push the north jetty as far as possible with the expenditure of $175,000, the amount specified for the first season's work; then work to be pushed on both jetties if conditions were favorable.

The work was done by John C. Bull, jr., under contract of December 16, 1892. It began in March with the laying out of the curves for the shore track on the North Spit. This was done by Mr. A. J. Butler, civil engineer, acting for Mr. D. E. Hughes, assistant engineer. The shore end of the track on the dike was moved to one side and about 1 foot was sawed off the inner ends of the first stringers of this track. This will partly account for any discrepancy in the length of this trestle now, as compared with the length of the dike at the North Spit given in previous reports. When the last bent, 92, of the dike was put in repair before the commencement of new work, the length of the span from 91 to 92 was shortened about half a foot. Hence the old work at the North Spit is now 1,479 feet long, instead of 1,480.5 as formerly. The length of new track as paid for is 1,479.5 feet, but this comes from a gain of 0.5 foot in a reversed curve where double track begins, the track being 0.5 foot longer than the trestle.

Mr. Hughes arrived at Eureka on April 2, 1893, and took charge of the work the next day. The contractor began constructing shore track during the first week in April. On April 12 the work of repairing trestle began. The first load of rock arrived at the North Spit April 14, and was dumped the next day from bent 25 to bent 44 of the north dike.

At a point 654 feet from the shore end of the trestle on the North Spit, a double track was begun. From this point to bent 91 the double track was laid on the old trestlework. Bent 92 had moved both horizontally and vertically, so new piles were driven for this bent.

On May 10 new work began. Seven bents of piles were driven by May 13. The last five of these were tied together by 2-inch plank spiked on each end of the caps. By Monday morning, May 15, the scour had become so great (11 feet in some places) that the pile-driver was withdrawn from the end of the trestle. That same day, the sea being rough and the tide high, two piles were carried away from bent 94. They were replaced that day, but that night two more were lost in 94 and two in 95. On the next day bents 97, 98, and 99 were lost. During that week all the new work was lost, together with a mat at bents 92 and 93, which was dropped while incomplete. The loss to the contractor was 30 piles and other material, as caps, stringers, poles, and brush.

After this accident the pile-driver was remodeled. It was mounted on a 4-wheeled truck running on the inside rails of the two tracks. This was a great improvement over the method of supporting the driver by skids, as was done at first.

Beginning at cap 91 the jetty was built in the form of a curve of 394 feet radius. This curve extends to bent 111, where another curve begins having a radius of 780 feet. The third curve begins at bent 148 and has a radius of 2,500 feet. The fourth and last curve begins at bent 202 and has a radius of about 30,000 feet. According to the present project the entire remaining portion of the jetty will be on this curve. The plan for getting the piles driven in their proper places while building a curved portion of the jetty is as follows: A driftbolt is placed in each end of a cap, 12½ feet distant from the middle, and is allowed to project a few inches above the cap. The distance each pile of the next following bent must be from each of the two driftbolts of the last driven bent is computed. Two chains are made with these lengths specially marked by large links. These two chains are attached to the pile-driver so that they meet at the point occupied by the center of a pile standing in the gins ready for driving. To get the driver into position for any pile the proper links are slipped over the driftbolts of the last cap and the driver hauled forward and revolved till both chains are tight. The driver is then chocked in this position, a trip loosens the chains so that they are out of the way till wanted again, and the pile is driven. The whole operation is quick, accurate, and satisfactory.

During May the shore end of the trestle was protected by laying brush in bundles under the trestle and dumping rock on top of it. This was to prevent sand from being carried away from the trestle by the swell at very high tides. No more trouble was experienced at this place. In April a careful survey of the entrance was begun by Mr. Hughes. A base line was laid out on the south jetty. This base line is known A B in the system of triangulation. A is marked by an 8-penny wire nail on the south edge of the north stringer at a distance of 534 feet from the initial point (bent 0) of the jetty; B is marked by a broken wire spike on the south edge of the north stringer at bent 190. This line was found by measurement with a 500-foot steel tape to be 2,504.20 feet long. It is the basis of all the instrumental work done during the season. The survey was pushed as the weather permitted; the work inside the jetties was completed in June; the soundings outside could not be obtained till later in the summer, when the bar became smooth enough for work. The survey up to the end of June showed a practicable channel of 9 feet along the east side of the bay, known as the Bucksport Channel. There was a very deep channel (over 60 feet in some places) extending from the junction of the Bucksport Channel and the South Bay Channel out to the end of the south jetty. From the south jetty out over the bar, no soundings have been taken; the tugboat captains gave the depth in the Northwest Channel over the bar as 16 feet. The channel inside the entrance close to the North Spit, known as the west channel, was entirely closed up. The best water in the shoalest place in it was only 4 feet.

By an examination of the profile of the north jetty, it will be seen that the depth of water usually changed after the driving of the piles and before the sinking of the mattresses. Up to June 30 the piles in the new work had been driven in depths varying from 1 foot to 13 feet below zero; the average scour between time of driving piles and sinking mats was 0.2 feet. The maximum scour, 5 feet, took place at bent 114. There was a considerable length of the jetty where a fill took place after the piles were driven; the maximum fill was 5 feet at bent 121. The penetrations of the piles varied, according to the depth, from 9 to 18 feet; in every case a penetration at least equal to the depth of water was secured. The average penetration was about 12 feet.

The chief difficulty met with in the construction of mattresses was the weakness of the poles, especially those of alder, which broke very badly on being struck by rock. This caused the loss of considerable brush by the contractor. To partly obviate this the contractor was allowed to use rock of 20 pounds weight for sinking mats; later on he discontinued the use of alder poles altogether.

The cars used by the contractor for transporting rock were of two kinds, box cars and flat cars. The box cars had floors of a hog-back shape, giving an inclined surface on which the rock rested. By the use of crowbars most of the rock loaded in these cars could be dumped with little difficulty. The flat cars, however, had horizontal bottoms, and it was found very difficult to move the large masses of 4 and 5 tons that came on them occasionally. Mr. Butler, who was employed as engineer by the contractor after the arrival of Mr. Hughes, devised an improvement that greatly increased the usefulness of the flat cars. It consisted in using a tackle, by means of which large rock in a car standing on one track could be pulled from the car by a locomotive running on the other track. This method was afterwards applied to the box cars when the rock in them could not be dumped easily by hand.

The first injuries to the trestle of the south jetty occurred April 4, when two piles and a stringer went out at bent 225. More went out about the middle of May and more about the 10th of June, making in all 10 bents lost up to the end of June.

At the close of the fiscal year the condition of the improvements was as follows: The south jetty remained as at the beginning of the season, with the exception of the 10 bents of trestle lost as just mentioned. The trestle of the north jetty had been extended to bent 152, a length of 2,439 feet; mattresses had been sunk to 8 feet beyond bent 142, a length of 2,287 feet.

Work on the north jetty was still in progress. The depth of water in which piles were being driven at that time was 3 feet; mattresses were being sunk in 5 feet.

The route followed by ocean vessels leaving the harbor was along the east side of the bay in the Bucksport Channel, to its junction with the South Bay Channel, near the South Spit; thence along the South Spit and the south jetty to the end of the latter; thence in a northwesterly direction over the bar. The worst part of this route was in the Bucksport Channel, near Beacon No. 7, where there was a stretch of about 500 feet having a depth of less than 12 feet, the least depth in a practicable channel being 9 feet.

The chief items in the work done by the contractor up to this time were as follows:

Rock	tons..	14,224
Brush	cubic yards..	4,780
Trestle, complete	feet..	832
Shore track	do...	1,781
New single track on trestle	do...	825

The total earned under the contract up to the end of the fiscal year 1893 was $39,896.60.

On July 1 (the beginning of the fiscal year 1894) work on the north jetty was still in progress under the contract of December 16, 1892, with John C. Bull, jr., of Arcata, Cal. Mr. D. E. Hughes, assistant engineer, remained in charge of the work until August 3, on which date I assumed local charge, Mr. Hughes, however, remaining on the work under my orders.

The delinquency on the part of the contractor in regard to rock delivery continued. Promises were freely made, but they were not kept. The monthly delivery of rock for July, August, and September fell below the amount delivered in June, although this latter was over 1,000 tons short of the least amount required by the specifications. The rock in the quarry was broken up into small pieces, probably by injudicious blasting; hence there was a large amount of rock too small even for mattress sinking, all of which débris had to be moved while acceptable rock was being loaded.

On August 10 the pile-driving was stopped in order that completed jetty, which was about 1,600 feet behind the pile-driver, could be pushed to within 500 to 700 feet of the end of the trestle.

The last bent driven was 211. The contractor drove two piles in bent 212 and left his pile-driver in advance of 211 while the mattress enclosing 211 was being built. The contractor was then directed to furnish a large proportion of large rock, under penalty of being restricted to large rock alone in the near future, while pile-driving was suspended. However, he continued to furnish about equal proportions of large and small rock till the 1st of September, after which he was restricted to large rock until resumption of pile-driving.

During July evidences of scour began to appear in the vicinity of bent 100, north jetty. This was due to the ebb current following the deep channel along the west side of the bay and striking the projection formed by the bend in the jetty. Soundings taken July 31 showed a depth of 16 feet below 0 at a distance of 17 feet from the outside pile of the trestle at bent 90, and a half foot less at bent 95. This condition was deemed serious enough to call for an attempt to stop the scour, hence it was decided to build a spur at bent 92 to deflect the ebb current. The contractor drove two piles about 17 feet from the outer rail and about 16 feet apart.

A mattress was constructed with these two piles and the main trestle as a support. On the 18th of August, when the mattress was about half done, the cap on the two extra piles broke, dropping the mattress to the water, together with several men working on it.

One man was severely injured by being struck by a 12 by 14-inch stringer. This was the most serious accident that occurred on the jetties during the whole season. After the accident the mat remained lying on the water; a top grillage was arranged, part of the lashings were made fast, and the mat was sunk. It was sufficiently complete to serve its purpose, if properly sunk and loaded with rock. That night the mat and the two extra piles were carried away, presumably by the strong ebb tide. The piles were driven about 15 feet in the sand; the depth where they were driven was about 12 feet. There must have been a scour reaching down to within about 3 feet of the bottoms of the piles before they went out, hence there must have been a depth of 24 feet below 0 at a point 15 feet from the outer piles of the trestle. The obstruction having been removed the hole quickly filled up.

Another mat was built and sunk by an entirely different method. The mat was built on the brush scow and launched from it. Three stringers, each 12 by 14 inches by 32 feet, were placed longitudinally on the scow about 10 feet apart between centers. One end of each stringer was at the bow of the scow and rested on the deck; the other end was elevated about 1 foot. On each stringer were placed several wooden rollers about 8 or 10 inches in diameter, on top of which a plank was laid as a support for the lower grillage of the mat. The mat was prevented from rolling off the scow prematurely by chocks under the rollers and ropes fastened to the planks and made fast at the stern of the scow. The mat was built as usual, except that a layer of rock was placed in the mat near the top, over which brush was placed. This rock, being placed in the mat, could not roll off if the mat should happen to have a steep inclination while being launched. When the mat was completed more rock was placed on top of it by hand, and the scow was towed out to bent 92, and its bow placed toward the jetty. Guy ropes attached to the corners of the mat next to the trestle were made fast to the trestle with sufficient slack to allow the mat to sink where desired.

The chocks were then taken from the rollers, the ropes at the stern of the barge loosened, and the barge pulled from under the mat by a towboat. The mat went down successfully. Rock was then dumped on it from the trestle, and the spur was built up till the part next to the trestle was as high as the finished jetty.

The mat for the spur was sunk on the 23d of August. The effect of the spur could be seen plainly during ebb tide; the current was deflected, and an eddy was formed on the downstream side of the spur. On August 15, eight days before the mat was finally put down, the depth at 30 feet from the center of the trestle at bent 90 was 13.5 feet. On August 29, six days after the mat was sunk, the depth at the same place was 8 feet. There was not yet any improvement at bents 95 and 100, but a decided deposit of sand was formed here later on. This new sand was not all permanent, however; some of it was washed away by the strong ebb tides late in the fall.

But up to the time of closing work in February, 1894, the depth at no point along that part of the jetty was great enough to cause alarm. The spur required periodical renewal. The rock appeared to roll off the edge of the mat; it is probable that the edges of the mat were undermined from time to time by the scour of the ebb tide.

The spur was built up in November and again in January, 1894. The material used in this spur up to the end of the season's work was 80 yards of brush, 200 tons of rock in August, 80 tons in November, and 50 tons in January. The total cost of the spur was about $550.

On August 28 the mat at the end of the trestle then standing was sunk in 13 feet of water. Before pile-driving was resumed in October some scour had taken place here, so that the driving of piles in the fall was begun in deeper water than had been usual during the summer, and the scour around the end of the trestle kept the water deep ahead of the pile driver.

During September, Mr. D. J. Flanigan assumed the general superintendence of the contract work. He introduced some improvements which increased the rock delivery. The chief of these were the telephone from the North Spit to Flanigan's Mill, at Eureka, putting the jetty in communication with the quarry; the introduction of an electric light in the quarry for night work, and the regulation of the amount of powder used in blasting. The effects of these improvements were manifested in October and November, during each of which months over 10,000 tons of rock were delivered.

Pile driving was resumed October 2, the completed jetty having been brought to within 640 feet of the end of the trestle.

The depth was then 16 feet. The piles were required to be driven to a penetration of at least 15 feet, and a record was kept showing the penetration of each pile.

The average penetration of the piles in the trestle built after this time was 15.2 feet.

The average depth in which the piles were driven was 12.7 feet.

In this depth and at this time of year the work of pile-driving could not go on rapidly. It was usually smooth enough to work on the ebb tide, but it was exceptional for the water to be smooth enough for pile-driving on the flood tide. The scour that took place after the piles were driven increased the depth so that the mattresses in this part of the work were sunk in an average depth of 17 feet. The mattresses in this part of the work were thinner than in the earlier work. They had to be kept as high as possible during construction, in order to keep them out of reach of the sea, so the sling poles were put 2 feet higher and the mats built up to the caps. The method adopted for sinking mats under the present contract is worthy of remark. Formerly on this work trips were used, but they sometimes failed to operate.

The method used during the past season was as follows:

The sling poles on which the lower grillage rested were suspended from the caps by wire cable. A thimble was put in each end of a wire cable about 16 feet long; the cable was passed under the sling pole and the two thimbles were placed about 6 inches apart on top of a cap and lashed together with several thicknesses of ratline. When the mat was to be sunk, the ratline was cut with an ax at a signal given by the foreman. To prevent the loss of the cables each time a mat was sunk, one end was secured to the cap with a chain. The other end pulled through the mat as the latter fell.

Beginning August 10, the contractor used annealed wire of about the same strength as 18-thread ratline for lashing the mats. There is probably little advantage in the use of wire except its cheapness.

A crossover between the two tracks of the north jetty was built early in October. It was placed between bent 164 and bent 171. It was a great convenience in handling rock, as part of a car of large rock was usually dumped from one track, then the car put on the other track and the remainder dumped.

Before the construction of the crossover the train had to go back to the beginning of the double track to pass from one track to the other. The cost of the crossover was $250.75.

There was a slight amount of rain late in September and early in October; the greater part of the fall was very favorable, however.

The first great storm began on November 22. There was a slight rain that day and the next; the next following day, the 24th, was very stormy. At this time the trestle extended to bent 264; mats were sunk to bent 255; a mat was completed and was hanging on 256 and 257. It was ready to be dropped late on the 23d, but by one of the slips so common during the season, the rock failed to arrive, so the mat hung over night. This was the time of spring tides, high tide occurring a little before noon. At 9:45 a. m. on the 24th, a heavy sea struck the suspended mat and broke out bents 256 and 257, on which it hung; a few seconds later the floating débris of the mat and trestle broke out bents 254 and 255, and the contractor's pile-driver, which had been hauled back to bent 253 for safety, ran forward and pitched into the ocean.

About half an hour later bents 258 and 259 were broken out by the sea. They had each a sling pole suspended from the cap, perpendicular to the jetty, for the support of the next mattress. The sling pole, on bent 258, was on the inside of the piles of the bent; that of bent 259 was on the outside or toward the sea. When a heavy sea came the sling pole on bent 258 swung away from the piles, but the sling pole on bent 259, being on the outside, was driven hard against the piles when struck. It would have been supposed that bent 258 would be carried away before 259, the former being nearest the break and already weakened in some of its joints, and having nothing behind it to support it. But bent 259, doubtless on account of the additional surface exposed to the sea by the sling pole (about 12 inches in diameter and 50 feet long), gave way first. A heavy sea forced the cap loose from the stringers and broke off all four piles without breaking any of them loose from the cap. The cap and piles fell inward against bent 258, and the next sea carried it away in like manner. The pile-driver was carried by the waves and the tide to a point just to the west of the cross channel between the jetties, where it grounded on the sand. The bottom framework, the truck on which the driver was mounted, and the engine, were saved almost uninjured. The hammer and the gins were lost.

By this storm the contractor lost 6 bents of trestle, 1 mattress containing about 150 cubic yards of brush, a pile-driver hammer, a part of a pile-driver framework, and some tools and ropes, the whole amounting to upwards of $1,000.

This accident left 5 bents of trestle, 260 to 264, standing alone, without any mattress or rock around them, and separated from the rest of the trestle by a gap of 112 feet. They stood for two weeks without any serious damage. They were shifted in position, but not enough to introduce any considerable crook into the jetty. The pile-driver was rebuilt, a new hammer was obtained, and the work of repairing the gap began on December 12. Bents 254 and 255 had to be redriven through small rock and mattress work, but this was done readily and the gap was soon closed.

One additional bent, 265, was driven; pile-driving was then stopped. Mattress work was extended 7.5 feet beyond the last bent of piles, and a layer of 2 feet of rock was placed on the last two bents of mattress work. The work was then confined to completing the jetty to bent 225, and building up the slope from there to the outer end to approximately a uniform grade.

Owing to bad weather this work proceeded slowly. It was finally finished February 2, 1894.

About the middle of January, 1894, a large log, 85 feet long, reached the north jetty on the west side near the shore end and broke off 7 piles, as follows: One each in bents 55, 56, 57, 58, and 59, and 2 in bent 60. As the contractor's pile-driver was dismantled for the winter, he was notified that these piles could be replaced at his expense in the spring, instead of before close of the work.

Cross sections at every fifth bent of the north jetty and a side elevation of the crest of the rock in the north jetty were taken just before the close of the work. The following elevations of the tops of the caps above tide-gauge zero will give an idea of the grade of the track on the trestle:

	Feet.		Feet.
Bent 0	12.98	Bent 150	22.49
Bent 25	17.29	Bent 175	22.80
Bent 50	18.35	Bent 200	23.17
Bent 75	18.84	Bent 225	23.44
Bent 100	19.29	Bent 250	23.96
Bent 125	21.93		

The outer end of the north jetty was left in the following condition for the winter:

In the last bent an extra driftbolt of 1⅜-inch round iron 2 feet long was driven into each pile through the cap. An extra cap was placed across the last bent on top of the stringers and a ¾-inch round iron screw bolt was put through cap, each stringer, and extra cap, and secured with a nut. The next 2 bents from the end had one extra 1⅜-inch driftbolt placed in addition to each driftbolt of the regular construction. The next 12 bents were simply doubly driftbolted with ⅞-inch driftbolts.

The experience with the south jetty has shown that, with comparatively shoal water ahead of a trestle, the chief danger is from drift logs that break the piles loose from the caps and stringers and then break the piles off.

Anything that will prevent the piles from being broken from the caps and stringers will make them much harder to break off.

From soundings taken at various times during the summer near the south jetty it was learned that the channel was encroaching on the jetty. To stop this it was decided to build spurs.

The first spur was built August 18 on the sand opposite bent 80. It was located as far out as could be done consistently with allowing it to be built in place on the sand. It was loaded with small rock. The mattress was 57 by 25 feet in plan, the longer dimension perpendicular to the jetty, so rock had to be carried out to the outer end of it. Spurs of brush and rock were built at bents 100, 120, 135, and 150. The mattresses were built and launched as previously described for the spur at bent 92, north jetty.

They averaged about 36 by 25 feet in plan, the longer dimension perpendicular to the jetty, and 3.3 feet in thickness. The small rock was carried out to the middle of the spurs by a chute made of plank. To get the large rock out to the outer ends of the spurs a steam crane running on the trestle track was used. The large rock was dumped off the outside of the track till a heap was made, then the crane picked it up piece by piece and swung it out to the outer end of the spur. At bents 165 and 190 spurs were built of rock alone. It was impracticable to put mats under these spurs; the water was deep and rough, and the sand so steep that there would have been no certainty of getting the mats where they were wanted. The rock was simply dumped off from one bent and allowed to take its natural slope. The cost of these 7 spurs on the south jetty was as follows: The spur at bent 80 contained 122 cubic yards of brush and 245 tons of small rock; cost, $492. The spur at 100 contained 98 cubic yards of brush, 353 tons of small and 24 tons of large rock; cost, $636. The spur at 120 contained 105 cubic yards of brush, 426 tons of small and 36 tons of large rock; cost, $760. The spur at 135 contained 119 cubic yards of brush, 338 tons of small and 85 tons of large rock; cost, $726. The spur at 150 contained 111 cubic yards of brush, 414 tons of small and 147 tons of large rock; cost, $900. The spur at 165 contained 386 tons of small and 293 tons of large rock; cost, $910. The spur at 190 contained 310 tons of small and 372 tons of large rock; cost, $913.

The effect of these spurs was to cause a continuous sand bank to form out to bent 150. Beyond that point there was no perceptible benefit derived from the spurs. Before the end of the season the spurs at 165 and 190 had subsided very noticeably, and the large tides during the fall had caused between these two points an increased scour and a greater depth than during the summer. Just beyond bent 150 a decided settlement of rock occurred in the main jetty. This was all confined to one bent, but it went down about 3 feet. It should be noted that at bent 94, north jetty, just outside of the spur at bent 92, a similar thing occurred. No satisfactory explanation of this has been reached; it may be due to an eddy formed just on the downstream side of the spur, which undermines the jetty at that point.

Besides the construction of spurs, no other work was done on the south jetty except filling up some gaps in the jetty and the necessary preparatory work, such as laying track on the trestle and repairing shore track. After the completion of the spurs, extra driftbolts were placed in the last 14 bents, 206 to 219 inclusive. (Bent

220 had been carried away early in July.) The object of this was to make the trestle strong enough to stand the coming winter.

It stood all right until the storm of November 24, referred to above; then the last cap was displaced slightly. Struts were then placed from the piles of the outer bent back to the cap of the next bent. These did not avail, however. The stormy weather, acting in conjunction with the high tides, carried out 8 bents on the 21st of December, leaving bent 211 the last one standing. Bent 209 was injured at the same time by having 2 piles broken out. Three days later bents 209, 210, and 211 went out. The destruction of this trestle at this time was doubtless due to the increased depth of water ahead of it. It was built in shoal water. During the past season the water ahead of it became 40 to 50 feet deep; hence the sea, instead of being broken by the shoals, reaches the jetty with full force.

On January 3 the last 3 bents then standing, 206, 207, and 208, were reenforced by putting 1⅜-inch driftbolts in piles, caps, and stringers. No more trestle was lost up to the time of closing work, although some bents a short distance from the end were damaged by drift logs.

The total loss to the Government on this jetty has been 22 bents of trestle and a few piles, the number probably not exceeding 10.

The survey of the entrance, begun in April, was not fully completed till August. The soundings showed a channel of 21.5 feet over the bar, extending in a northwesterly direction from the opening between the jetties.

About the 1st of August there were signs that the old west channel was about to open. The spring survey had shown a depth of 12 feet as far as bent 120, north jetty, but there was no practicable outlet into the main channel near the south jetty. On August 6 a depth of 8 feet was found in this channel; August 15, 10 feet was found. No further increase in depth occurred at this time; in fact, by October 20 the channel had shoaled to 8 feet, but 9 feet was found on October 30. The tugboats had already begun to use this channel for towing light vessels into harbor, and shortly after this time another increase took place and the San Francisco steamers began to use it. The channel was not surveyed after the middle of December, when a depth of 10 feet existed, but the tugboat men reported about the 1st of February a depth of 15 feet in this channel. Practically all of the commerce of the harbor was passing through the channel at this time.

A general survey of the entrance and bay was made during November and December, 1893. The survey showed a depth of 10 feet in Bucksport Channel, a depth of 10 feet in the west channel, and two channels over the bar—one the same channel that was found in the summer, moved farther north in position, and the other extending from the deep water near the end of the south jetty in a southwesterly direction over the bar. The former had a depth of 19 feet and the latter 18 feet, but the latter was preferred by the captains of the tugs because it was a shorter route over the bar, and because it was an easier channel to tow in, on account of its direction with respect to the prevailing winds. The most common winds in Humboldt Bay are the northwest and the southeast. With either of these a vessel has a beam wind when passing through the southwest channel over the bar in either direction.

By comparing the map of November and December with that of April to August it will be seen that the most noticeable changes in the harbor were the opening of the west channel inside the entrance and the opening of the southwest channel over the bar.

Besides the opening of these two channels it will be noticed that the northwest channel over the bar became shoaler and that it moved to the northward. The high-water line on the ocean side of the north jetty had pushed out about 300 feet; the low-water line remained almost exactly as before, except that a tongue of sand 500 feet wide reached out in a southerly direction to the jetty at bent 170. The high-water line on the south side of the south jetty pushed out 200 feet; no great change in the low-water line took place here. There was but little change in the high and low water lines on the bay side of either jetty.

During the season a channel of at least 16 feet was maintained over the bar and a channel of 9 feet within the bay. No vessels were prevented from leaving the harbor on account of lack of depth on the bar, although on a few occasions they were prevented from doing so by rough sea.

The route usually followed by vessels at the close of the work for the season was along the west side of the bay to the sharp curve of the north jetty, then across toward the end of the south jetty to the deep channel, thence southwesterly across the bar.

During September a series of current observations was taken in the entrance. The currents were observed by rod floats made of wood, about 8 feet long and 2 inches in diameter. Four sets were taken one for the flood and one for the ebb along each jetty. Each set consisted of six floats started from a rowboat. They were observed with a transit and the paths plotted on a map. In the west channel inside the entrance a maximum velocity of 3 feet per second was observed on the flood tide and a velocity of 5 feet per second on the ebb tide. In the deep channel along the south jetty maximum velocities of 6.1 feet per second on the flood and of 7.4 feet per second on the ebb tide were observed.

For the purpose of investigating the action of teredo in this locality, two of the stray piles that had remained standing after the destruction of the outer 11 bents of the south jetty trestle in the spring were broken off, cut up, and examined in October. They showed the presence of teredo, but not in sufficient numbers to materially weaken the piles.

On December 26 the true meridian was located by an observation of Polaris at culmination. This meridian is plotted on the map containing the results of the survey of November and December.

On December 28 the self-registering tide gauge was moved from the South Spit to the North Spit and set up on the light-house wharf.

During the season a large amount of sand was impounded on the north side of the north jetty. At the end of the season this sand was bare at 0 tide out as far as bent 170. Inside of this point, however, from bent 105 to bent 130 there was an area still under water. Sand also accumulated on the south side of the north jetty from the sharp curve out for some distance. This sand was above 0 from bent 125 to bent 170.

At the close of the season the north jetty had a length of 265 bents, 4,248.6 feet, of which 3,608 feet were completed up to +10 feet, the height of the highest storm tide on record. The south jetty remained as before, 3,699 feet long; the trestle remained standing to bent 208, a length of about 3,340 feet.

The progress of the work during the season was as follows:

	New trestle completed, north jetty.	Brush.	Rock.	
1893.		*Cubic yards.*	*Tons.*	*Pounds.*
April			744	1,040
May	112	497.52	4,572	820
June	720	4,282.06	8,907	600
July	656	3,764.02	7,916	1,170
August	417	2,110.36	8,205	1,595
September		432.83	8,451	1,725
October	384	1,955.74	11,252	1,570
November	192	1,467.29	10,030	1,220
December	112	596.62	6 347	1,700
1894.				
January	176.6	131.27	5,642	2,200
February			624	730
Total	2,769.6	15,237.71	*72,696	930

* There were $36{,}043\frac{180}{2240}$ tons of large rock and $36{,}653\frac{750}{2240}$ tons of small rock.

The amount earned during the season was $156,639.21.

In order to ascertain the cost of jetty construction in different depths, the following data have been prepared from the records:

Bent.	Depth under mat.	Thickness of mat.	Small rock.	Large rock.	Cost of bent complete.	Cost per foot of jetty.
	Feet.	*Feet.*	*Tons.*	*Tons.*		
188	5	3.22	128	193	$657.98	$41.12
107	10.8	4.16	137	174	681.07	42.57
223	16.3	2.89	340	298	1,094.34	68.40
215	21	2.75	466	281	1,241.96	77.62

The approximate equality of the cost of bents 188 and 107 is rather surprising. On its face it would indicate that the jetty could be built almost as cheaply in 10 feet of water as in 5 feet.

It may be noted that at bent 107 the mattress was 44 feet wide, while at 188 it was only 39 feet wide. It may be that at the latter bent some of the rock rolled off the mattress and was buried in the sand. There was not a very great difference in the cost in 16 feet of water and in 21 feet. In the latter depth only about 100 tons of rock per bent were required in addition to the amount necessary in the former depth. As the jetty progresses the exposure to the sea increases, making necessary the use of more rock to replace that beat down by the sea.

I desire to express my appreciation of the careful and constant attention paid to the work by Mr. D. E. Hughes, assistant engineer, and Messrs. Frank G. Swall and Floyd Moulton, inspectors. The advice and assistance of Mr. Hughes were especially valuable in the management of the work.

Very respectfully, your obedient servant,

HERBERT DEAKYNE,
Second Lieut., Corps of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

STATISTICS OF TRADE.

The following complete statistics of trade of Humboldt Bay for the year from June 1, 1893, to May 31, 1894, were collected and furnished by the Humboldt Chamber of Commerce, Eureka, Cal.

Movement of vessels, twelve months ending June 30, 1894.

	Steam.	Sail.	Tonnage.
Arrivals	238	285	153, 409
Clearances	237	285	152, 304
Total crossing bar	475	570	305, 713

Passenger movement.

Arrivals per steamers	7, 737
Departures per steamers	7, 464
Total crossing bar	15, 201

Exports.

	Tons.		Tons.
Timber products	210, 815	Oats	1, 073
Butter	1, 528	Leather	325
Wool	327	Miscellaneous	1, 575
Produce	1, 445		
Fish	453	Total	217, 541

Imports.

There were no imports direct from foreign countries during the period under review, and the statistics of importation from domestic ports are not obtainable

Draft of vessels.

The maximum draft of vessels entering the harbor during the year was 19 feet. The average draft of laden vessels is perhaps 13 feet.

The following statement of the freight carried by the steamer *Humboldt* between Eureka and San Francisco was furnished by the agent of the steamer:

	Tons.
San Francisco to Eureka	7, 625
Eureka to San Francisco	3, 332
Total	10, 957

The following statement of the freight and passengers carried on the steamer *North Fork* between Eureka and San Francisco was furnished by Capt. Charles Nelson, the agent of the steamer:

General merchandise from San Francisco	tons	4, 640
General merchandise to San Francisco	do	870
Lumber to San Francisco	do	16, 800
Total		22, 310
Passengers from San Francisco		388
Passengers to San Francisco		392

The following statement of the freight, treasure, and passengers received and delivered at Humboldt Bay from June 1, 1893, to May 31, 1894, by the steamers of the Pacific Coast Steamship Company was supplied by Messrs. Goodall, Perkins & Co., the general agents of the company:

Received at Humboldt Bay:	
Freight, in tons	8, 471
Treasure	$101. 743
Passengers	4, 266
Delivered at Humboldt Bay:	
Freight, in tons	5, 631
Treasure	$179, 055
Passengers	4, 415

APPENDIX U U.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN OREGON, WASHINGTON, AND IDAHO.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, CAPT. THOMAS W. SYMONS AND LIEUT. FRANCIS R. SHUNK, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Coquille River, Oregon.
2. Coquille River, Oregon, between Coquille City and Myrtle Point.
3. Entrance to Coos Bay and Harbor, Oregon.
4. Umpqua River, Oregon.
5. Mouth of Siuslaw River, Oregon.
6. Yaquina Bay, Oregon.
7. Tillamook Bay and Bar, Oregon.
8. Entrance to Nehalem Bay, Oregon.
9. Upper Snake River, Idaho, between Huntington bridge and Seven Devils Mining District.
10. Upper Columbia and Snake rivers, Oregon and Washington.
11. Columbia River between head of Rock Island Rapids and foot of Priest Rapids, Washington.
12. Willapa River and Harbor, Washington.
13. Grays Harbor and Chehalis River, Washington.
14. Chehalis River, Washington.
15. Harbor at Olympia, Wash.
16. Swinomish Slough, Washington.
17. Puget Sound and its tributary waters, Washington.
18. Everett Harbor, Washington.

HARBOR LINES.

19. Everett Harbor, Washington.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, July 10, 1894.

GENERAL: I have the honor to forward herewith * * * annual reports for the year ending June 30, 1894, for the works of river and harbor improvement under my charge.

Very respectfully, your obedient servant,

T. W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

U U 1.

IMPROVEMENT OF COQUILLE RIVER, OREGON.

GENERAL IMPROVEMENT.

Description of original condition.—At the time the work of improvement was begun the entrance to the Coquille River was considered very dangerous. It was by a long, tortuous, and narrow channel skirting the south headland and studded with rocks from beyond the bar on the outside to a distance of one-half mile inside. The depth at low water was only about 3 feet, and the position of the bar channel was constantly shifting. The channel sometimes, at long intervals apart, broke through the north spit, and ran directly out to sea just south of Rackliffe Rock, but did not remain long in this position. The entrance at such times was comparatively safe, and the channel was at its very best. The mean rise of tide was 4.1 feet.

Plan of improvement.—The plan of the improvement is to construct two parallel high-tide stone jetties, 600 feet apart, running out to sea a sufficient distance to open and maintain a channel over the bar with a least depth of 8 feet at low water, the north jetty starting from Rackliffe Rock and the south jetty from a point on the left bank inside the entrance. The cost of this work, as estimated in 1878 by Maj. J. M. Wilson, is $164,200. The law of August 11, 1888, authorized in addition $5,000 to be expended for snagging between Coquille City and Myrtle Point.

The law of September 19, 1890, authorized an amount not to exceed $3,000 to be used in snagging.

Under date of May 8, 1891, the plan of improvement was changed to provide for an entrance width of 600 feet instead of 800 feet.

A careful estimate of the cost of completing the works at the entrance to the Coquille in accordance with the plan of improvement given above was made in 1892, and it was found to be $180,000. The correspondence on this subject is given under the head of "Recommendations and remarks," p. 2663, Report of Chief of Engineers, 1892.

Up to this time $105,000 had been appropriated for the work. This makes the total estimated cost of the work $285,000.

APPROPRIATIONS.

Act of—	
July 14, 1880	$10,000
August 2, 1882	10,000
July 5, 1884	10,000
August 5, 1886	20,000
August 11, 1888	25,000
September 19, 1890	30,000
July 13, 1892	25,000
Total	130,000

The estimated cost of completing the project is $155,000.

Amount expended to June 30, 1893.—The amount which had been expended on the project for the improvement of the mouth of the Coquille to June 30, 1893, was $112,233.67, and the amount expended for snagging was $6,883.90, a total of $119,117.57.

Results obtained to June 30, 1893.—The entrance has for considerable periods been straight, and with a depth of from 8 to 10 feet at low water, but winds and currents have at other times heaped the movable sands into the channel, causing the waters to spread out over a wide angle, or the channel to break away to the northward, shallow in depth and bad in direction. A study of the various changes at the mouth of the Coquille led to the belief that the best results could not be attained unless the channel was kept from breaking away to the north and the northern sands were kept from encroaching on the channel.

To this end the north jetty was commenced, and it was extended a length of 510 feet seaward, as far as it could be done with the appropriation of September 19, 1890. The result was to considerably benefit the channel by prolonging the periods when the entrance is in good condition.

The work done during the fiscal year ending June 30, 1893, was almost entirely confined to completing in a substantial and permanent manner the incomplete and damaged work of former years.

As regards the condition of the entrance, the results obtained are practically the same as stated for the preceding years.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $8,868.03.

Results obtained to June 30, 1894.—The work during the year was confined to strengthening the south and north jetties. Neither jetty was extended, and the condition of the entrance is about as previously reported.

Report of operations.—Work of repairing and strengthening the south jetty continued during July, August, and September, 1893. Up to September 30, 3,621 cubic yards of rock were quarried from the Tupper Quarry, and deposited along the south jetty. On September 30 the work ceased. During November the north jetty tramway was seriously injured by drift. This was repaired during November and December.

On account of the great amount of drift at the mouth of the Coquille, constant watchfulness and care have to be exercised over the jetties to prevent the tramways being destroyed.

Recommendations and remarks.—The completion of the Coos Bay, Roseburg and Eastern Railroad from Coos Bay to Coquille City and Myrtle Point will enable the Coquille Valley to receive many of its supplies and ship many of its products by way of the railroad and Coos Bay. This will tend to detract from the old-time importance of the Coquille entrance.

It is proposed, with any new money that may become available, to extend the south jetty, changing the character of the work from a close pile and stone jetty to an open pile-work tramway, from which a stone jetty will be built, as at other coast points.

Nearly all the last appropriation has had to be expended in repairs to old work. It is hoped that, these repairs being made and the change of plan adopted, a marked advance can be made with any new funds that may become available.

An appropriation of $50,000 is recommended as the amount of money that can be profitably expended during the next fiscal year.

Future operations.—With any new funds that may become available it will be proposed to extend the south jetty as far toward completion as practicable.

The report of Capt. R. S. Littlefield, in personal charge of the work, is herewith.

Money statement.

July 1, 1893, balance unexpended	$10,933.95
June 30, 1894, amount expended during fiscal year	8,868.03
July 1, 1894, balance unexpended	2,065.92
July 1, 1894, outstanding liabilities	600.00
July 1, 1894, balance available	1,465.92
Amount (estimated) required for completion of existing project	155,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF R. S. LITTLEFIELD.

BANDON, OREG., *June 15, 1894.*

CAPTAIN: I have the honor to submit the following report of operations "improving Coquille River, Oregon," for the year ending June 30, 1894:

Work of quarrying and dumping stone for the south jetty was carried on during July, August, and September, when active operations were suspended on account of exhaustion of the funds available. No new constructions, such as extension of jetty or track building, were made, but a locomotive house was built, mainly from old materials on hand and from what was left of the one demolished by a blast in May of the previous year.

The quarrying was done on a spur of, or detached mass from, the Tupper Rock, which mass was nearly all used, its base being about 35 feet below the level of the bluff on which the Tupper Rock stands, which depth went to the base of the spur. Considerable stripping into the bluff was necessary to work the rock, the dirt falling by caving, which dirt was readily got rid of, swinging it in boxes by the derrick and dumping same on the side slope of the hill where the derrick stood. During the winter the bents of the double-track incline leading to the level jetty tramway, 170 feet in length, moved downward at its feet by a gradual slide of the hill of 4 to 6 feet. The side slope leading to the bluff has a strata of blue clay near the surface, is springy, which, coupled with an unusually heavy rainfall last winter, accounts for this movement.

Quarrying and dumping rock.—A total of 3,621 cubic yards were placed as follows:

	Yards.
Inside piling compartments, near jetty end	513
Along channel side, open and close piling parts of jetty, 1,597 feet, and for 316 feet inshore from jetty end, on south side	3,108

That dumped outside, or along faces of the jetty, was mainly large rock in pieces ranging from one-fourth of a ton to 10 tons, and the quality of the rock for weight is such that seas do not toss it about.

The south jetty is now pretty well enrocked on its north or channel side, the only side necessary, as on the south side, for the greater part of its length, it is banked by the accretion formed during progress seaward of the work. On channel side of the open pile-work part of the jetty the rock ranges from 8 to 10 feet below the track, and along the close piling part about 2 feet lower. At close of operations, in September, the general level of the dump was marked on piles of the jetty adjacent, and examination now made shows no settlement to the mass of stone forming the dump, excepting that just at the end of the jetty, and for about fifty feet back on both sides the dump has flattened, bringing the top about two feet below the marks at point of greatest exposure to sea force.

Four piles were carried away at extreme end of the jetty. Some slight repairs were made to the south jetty piling by rebolting piles, etc., where at a former high-tide line they had been knocked inward by drift, but the work generally has stood intact. A day beacon, 16 feet high above the plane of the jetty, 8 feet square at base, and 3 feet square at top, was built near end of the work as an aid to vessels in entering the harbor.

North jetty.—In November, by a freshet in the river, drift in great masses, comprising whole trees, came down, which, after passing into the ocean, a large portion was thrown by seas back of or to the north side of the jetty, the deposit extending miles up the beach. The part coming in contact with the jetty piling during successive high waters had the effect of wearing the piles so some of them were easily broken. Successive repairs were made to this north side piling during November, December, February, and March; the repairs consisting of replacing piles with posts let into the ground and secured by wale pieces bolted through and through. Under the constant motion of the drift, however, during the freshet months the outside wale timbers wore and were split off, thus requiring renewals of such work, and at this date most of the posts are punched out, a result of drift by recent high tides. The worst effect was along the foreshore, high-water line to near low, where on north row of piles the longitudinal cap timber is raised 4 to 8 inches for a length of 165 feet. On south row of the piling the piles are uninjured, and only one length, 15 feet cap timber, is slightly raised from the piles. From present high bank of deposit and drift—250 feet shorewards from end—on the north side of the jetty the drift mass is 2 to 4 feet higher than the jetty.

Drift from this river seems interminable during the larger freshets; at times it lies in acreage masses at and off the bar, to extent of blockading the bar, tugboat, and all navigation—a condition of the harbor here usual to the winter season, and likely to be for some years, or until the timber along the river and at its headwaters is removed.

Conditions about the jetties.—The high-tide line, north side of the north jetty, is 250 feet in from end with the low-water line at end and passing the end in a northwesterly direction to a rounded point 200 feet seaward of the end.

On south side of the north jetty the high-water line is 340 feet inshore from the end, while the line of low water runs to end where the rock dump shows 16 to 18 feet below the top of work. A shoal channel, 1 to 3 feet deep, runs along near the work, leaving an oblong island at low water extending far beyond, between the wash channel and the ship channel, to the bar. Along the north or channel side of the south jetty a berme of sand and gravel, commencing at outer end of the open piling work, runs along the whole of the close piling part of the jetty; it is 40 to 60 feet in width, and rounds to a point 120 feet seaward of the jetty end, where the low-water line takes a southeasterly course and forms the low-water line of the beach south of the work, where, in contact with the work, the material forming the berme generally covers the rock dump and slopes sharply to the channel. The rock dumped on south side of south jetty and along curve of the quarry track, 316 feet inshore from end, is generally filled over with drift and deposit, except from present high-water bank, 90 feet in from end, from which point to low-water line the beach is steep. There was no extensive deposit made through this jetty this year like that of February, 1893, crowding the channel over the bar northward—an effect which was probably stopped by the high dump made along north side of the jetty.

The bar channel has been maintained steadier in one position—parallel to the direction of the north jetty—than for any year previous, with less vessel detention and a better average depth to the water.

The reference to low-water beach lines is to extreme low of a spring tide, or about 2 feet below mean low water for this harbor.

Shipbuilding.—There were built on the river the following-named vessels: Sealing schooner *Winchester*, 112 tons; at Myrtle Point, on the upper river, the small screw mail steamboat *Myrl*, not yet measured, but to go into commission on July 1.

Creameries.—Except one at Dairyville, 16 miles down the coast from Bandon, they are located on the Upper Coquille River and its branches, and properly belong to the commercial statistics of that part. The product of the Dairyville creamery was as follows:

Butter (19½ tons)	$7,800
Hogs	525
Total	8,325

There are many dairies down the coast tributary to this harbor where butter is made by hand. Coos County, lying west of the Coast Range Mountains, where the precipitation is large and constant, primarily from rains and fogs and dews, is destined to become a great butter-making country when the land is cleared. An effect of the creameries established, coupled with the very favorable climatic conditions and soil, is to turn attention in increasing ratio to this industry.

The woolen mill projected last year for this place is now completed, except for some parts of the machinery, and is intended to be put in operation by July 20 next. The main building—3 stories—is 150 feet by 50 feet; steam plant, 75-horse power, to run 640 spindles. Articles manufactured are to be blankets, flannels, cassimeres, and buggy robes. Number of men to be employed—40 to 50 hands.

The Coos Bay and Roseburg Railroad was extended this year from Coquille City to Myrtle Point, but its operation was much impeded during the winter of 1893-'94 by the freshets, which necessitated rebuilding portions of the roadbed three times. No extension beyond Myrtle Point is yet in progress this year, but it is reported that resumption of operations is contemplated.

Respectfully submitted.

R. S. LITTLEFIELD.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The Coquille River is in the collection district of southern Oregon. Empire City, on Coos Bay, is the port of entry. The nearest light-house is on Cape Arago, 12 miles northward.

The following returns relative to the commerce of the Coquille River are furnished by Capt. R. S. Littlefield, in personal charge of the work, and are for the fiscal year ending June 30, 1894:

Arrivals and departures of vessels.

Coastwise steam and sail vessels.	Number.	Aggregate tonnage.
Arrivals	64	6,649.49
Departures	63	6,548.29
Total	127	13,197.78

Out of this total the steam schooner *Bandorille* made 22 round trips; the steam schooner *W. H. Harrison* 1 round trip, and the remainder of the arrivals and departures were schooners and other sail vessels.

Maximum draft of loaded vessels, 9 feet.

One schooner, the *Winchester*, was built at Parkersburg during the year, her registered tonnage being 116.

Exports and imports.

Articles.	Quantity.
EXPORTS.	
Apples ..... tons	29.5
Butter ..... do	67.8
Broom handles ..... do	233.2
Cheese ..... do	8
Chinese goods ..... do	1
Chittim bark ..... do	44
Chickens ..... dozens	53
General merchandise ..... tons	90.5
Household goods ..... do	18.5
Hides ..... do	13
Horses	3
Lumber (5,142,500 feet, B. M.) ..... tons	10,285
Laths ..... do	73
Hogs (live)	20
Mining materials ..... tons	5
Matchwood ..... do	133
Potatoes ..... tons	36
Stave bolts ..... do	5
Salmon (fresh) ..... do	26
Salmon (cases) ..... do	190
Wool ..... do	8
Total ..... do	11,286.5
IMPORTS.	
General merchandise ..... tons	2,294.6
Cannery supplies ..... do	255
Machinery for woolen mill ..... do	189
Flour ..... do	115
Household goods ..... do	40
Total ..... do	2,893.6

SUMMARY.

	Tons.	Estimated value.
Total exports	11,286.5	$129,795
Total imports	2,893.6	144,650

U U 2.

IMPROVEMENT OF COQUILLE RIVER, OREGON, BETWEEN COQUILLE CITY AND MYRTLE POINT.

Description of original condition.—The Coquille is one of the principal streams of southern Oregon. It is navigated by coasting vessels from its mouth for 25 miles to Coquille City. This portion of the river has been obstructed at times, more or less, by snags, but no serious shoals have formed.

From Coquille City to Myrtle Point, a distance of 12 miles, the river is navigated by river craft. In this portion there has always been great trouble experienced in keeping the river navigable, owing to snags and bars. The various forks of the Coquille drain densely timbered territory, and at every freshet many trees, stumps, etc., are brought down. Some of these lodge at different points, forming isolated snags or are grouped together into jams. These snags and jams in turn cause deposits of sand and gravel, forming shoals.

Plan of improvement.—The plan of improvement adopted is to remove all bad snags obstructing navigation and tending to form bars in the portion of the river between Coquille City and Myrtle Point, and to contract the river into a channel 50 feet in width at certain points where shoals have formed, in order to cause these shoals to scour out and to maintain the desired navigable depth.

The estimated cost of the work was $26,000.

APPROPRIATION.

Act of July 13, 1892.. $5,000

In this connection it seems proper to note that previous appropriations have been made for this portion of the river by making certain sums appropriated for the improvement at the mouth of the river available for the work on the upper river.

The act of August 11, 1888, appropriated $25,000 and contained the following: "Of which $5,000 is authorized to be expended for snagging between Coquille City and Myrtle Point."

The act of September 19, 1890, appropriated $30,000, "not exceeding $3,000 of which may, with the approval of the Chief of Engineers, be used for snagging."

On these authorizations $6,883.90 was expended.

Amount expended to June 30, 1893.—The amount expended under the project to June 30, 1893, was $5,000.

Results obtained to June 30, 1893.—The work with the appropriation was confined to fitting up a snag boat and doing snagging on the river between Coquille City and Myrtle Point and building a small wing dam at Roberts Island, designed to throw more water into the main left channel.

The results immediately subsequent upon the completion of the snagging operations were gratifying, as the removal of the snags was accompanied by more or less scouring. It was found, however, that since the survey and preparation of plans made in 1891 a heavy deposit has been made in the upper portion of the stretch between Myrtle Point and Coquille City. At the time of the survey there were deep pools between the bars, which latter in some instances were dry, as far as navigation was concerned, at low-water stages. These pools have to a great extent filled up with alluvial deposit since the survey was made.

Amount expended during the fiscal year ending June 30, 1894.—No money was expended during the fiscal year ending June 30, 1894.

Results obtained to June 30, 1894.—No work was done during the fiscal year, and no results other than those enumerated above for the previous fiscal year were attained.

Recommendations and remarks.—The river between Coquille City and Myrtle Point is being rapidly filled up with sediment, snags, etc., so that an estimate made years ago for its improvement to give 4 feet of water is not indicative of what the improvement will cost now. The navigation interests can be somewhat benefited by a system of small appropriations, but the river can not be put into shape to keep itself open unless the whole amount of the appropriations required to complete the work is given in one sum. Even then it is certain that the river would require constant work to remove the snags which will accumulate after every freshet.

Small appropriations do not reduce the total amount required to construct the needed contraction works.

It is to be remarked that the Coos Bay and Roseburg Railroad is built and in operation between Coquille City and Myrtle Point. This railroad must of necessity decrease the navigable importance of the river between the two towns, which is, and must always be, a difficult river to navigate at low water.

A recent examination of the river shows that a large number of snags have accumulated. Captain Littlefield counted 27 plainly visible from Roberts Landing to Coquille City, and doubtless there are others invisible.

The sum of $5,000 will suffice to keep the river thoroughly snagged for two years. If deemed best to carry out the original project, the balance of the estimate, $21,000, should be given.

Future operations.—Future operations will depend upon the amount of money appropriated. If a small sum is appropriated as named in the pending bill, the river will be freed from snags, and perhaps some contraction work done at the worst places.

Money statement.

Amount (estimated) required for completion of existing project	$21,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	21,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Information relative to the commerce of the Upper Coquille River between Coquille City and Myrtle Point for the fiscal year ending June 30, 1894, has been collected by Capt. R. S. Littlefield, in local charge of works on that river, from owners of creameries and the steamboat line, and is as follows:

The commerce of the Upper Coquille is accommodated by one steamboat, the *Alert*, 57 tons capacity, and making one round trip each day between Coquille City and Myrtle Point, carrying passengers and freight and United States mail.

Following is the amount of freight carried during the year between the two points:

River traffic.

Description of freight.	Up trips, Coquille City to Myrtle Point.	Down trips, Myrtle Point to Coquille City.
	Tons.	*Tons.*
Hardware, machinery, and general merchandise	1,031	
Wool, butter, cheese, bacon, etc		474
Milk for creameries		83
Lumber	104	
Total	1,135	557

Total freight carried, 1,692 tons; estimated value, $150,000. Total number of passengers carried, 2,200.

INDUSTRIES.

Product of creameries.

Arago Creamery:	
27 tons butter	$13,420
20 tons cheese	4,368
25 tons live hogs	2,672
Coquille Creamery:	
26.9 tons butter	13,400
6 tons live hogs	600
Myrtle Point Creamery, 5 tons butter	2,485
Gravel Ford Creamery, 3.5 tons butter	1,739
Total	38,684

Of the creamery products only 5 tons (butter) was shipped by rail, via Coos Bay, to San Francisco; the remainder went to the mouth of the river via river steamboats and ocean steamer *Bandorille*, the latter navigating to Coquille Creamery to receive freight.

Owing to a continuous high stage of river, the *Alert* made her daily trips to Myrtle Point from November to the middle of April. Except for a rise in the river for a few days, due to rains, the head of navigation is at Roberts Landing, about 1 mile below Myrtle Point, the usual summer stopping place.

New industry.—At Coquille City last year J. S. Kanematz started an experimental station for raising silkworms with the result thus far of receiving a gold medal on his sample of raw silk sent to the World's Fair at Chicago. A mulberry orchard has been planted, and the conditions of climate are deemed very favorable to such industry.

Summary.—Total river freight, 1,692 tons; estimated value, $150,000. This includes value of creameries output, $38,684.

U U 3.

IMPROVEMENT OF ENTRANCE TO COOS BAY AND HARBOR, OREGON.

Description of original condition.—The obstructions which existed at the entrance to this harbor before the works of improvement were begun, consisted first, of the outer bar which is of sand and is shifting in character; and second, of the inner shoals formed by the sands which accumulate in the spring, summer, and autumn, during the times when the northwesterly winds prevail.

Under the action of these winds the spit on the north side advanced toward the south, contracting the navigable passage under Coos Head to a very narrow width, and usually making the outer channel follow the west side of the spit in a long and tortuous course across the bar.

The channel had at times broken through the north spit on a line, the general direction of which is from Fossil Point to a point just to the north of Coos Head. It was then direct, the depth of water was greatest, and vessels could enter or go out without trouble. The mean rise of the tide above the plane of reference was 5.6 feet.

Plan of improvement.—The project for this improvement, adopted in 1879, was to construct, at an estimated cost of $600,000, a jetty of wood and stone as might be found best, from a point 250 yards below the northern extremity of Fossil Point on a line toward the east end of Coos Head, this line in plan curving so as to be directed at its outer end to the head or a little to the north of it.

The object was to prevent accretion to the south end of the sand spit on the north side of the entrance and to open and maintain a deeper and more direct channel across the bar.

The present plan, adopted in 1889, under which operations are progressing for the improvement of the entrance to Coos Bay, consists in the abandonment of any further work on the Fossil Point jetty and the building of two high-tide jetties of stone, one from Coos Head and one from the southern end of the north spit, out toward the bar, ending at a distance apart of about 1,500 feet.

In addition to this the project includes the reclamation and holding of the sands of the north spit, to prevent as far as possible their blowing over into the harbor.

The estimated cost of the work as approved is $2,466,412.20.

APPROPRIATIONS.

Under old project of 1879:	
Act of—	
March 3, 1879	$40,000
March 3, 1881	30,000
August 2, 1882	30,000
July 5, 1884	30,000
August 5, 1886	33,750
August 11, 1888	50,000
Total	213,750
Under new project of 1889:	
Act of—	
September 19, 1890	125,000
July 13, 1892	210,000
Total	335,000

Amount expended to June 30, 1893.—The total amount expended in improving the entrance to Coos Bay to June 30, 1893, was $424,782.10. Of this amount $210,337.74 was expended on the old project and $214,444.36 on the new project.

Results obtained to June 30, 1893.—During the fiscal year the jetty tramway was extended a length of 4,432 feet, making a total length from the wharf of 9,232 feet. Center mattresses were laid over a length of 4,112 feet of the new work. A total length of 6,800 feet of side mattresses was placed.

There were used on the work 3,156 cords of brush fascines and 6,207 poles, and dumped upon the work 46,000 tons of stone.

There remained about 1,088 feet of tramway yet to be built to complete the jetty to its full length.

The construction of the jetty brought about the impounding of a vast amount of sand. The high-water line advanced along the jetty about 1,500 feet.

Soundings taken on the bar June 7, 1893, by Mr. J. S. Polhemus, showed a minimum depth of 12 feet at mean low water, with a direction of the channel nearly due west and head on to the seas. The tug masters all reported that during the winter of 1892-'93 there was a greater depth on the bar than reported above.

Amount expended during the fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $116,037.89.

Results obtained to June 30, 1894.—The work of construction was confined to the north jetty. The tramway was extended during July, 1893, a distance of 288 feet, when it was stopped. The total length of the tramway is 9,520 feet. This was mattressed throughout with center and side mattresses.

The work of enrocking the jetty was carried on throughout the year, and a total of 117,340.7 tons of rock were placed.

During the summer and fall of 1893, the depth on the bar remained about as usual before improvement—about 16 to 20 feet at high water.

During the winter, as the enrockment slowly grew, a marked change took place in the bar channel, and a depth of 28½ feet at ordinary high water was attained. A bar depth of 24 to 28 feet has been maintained ever since.

On June 14, 1894, Mr. Polhemus, on the *Wright*, made a survey of the bar channel, the results of which are shown on the map sent herewith. This indicates an excellent direction to the channel, and a minimum depth of 20 feet at the mean of the lower low waters.

While it is not proper to regard these depths produced by a single jetty as altogether permanent, they are very encouraging as indicative of what may be expected permanently when the work is completed.

Report of operations.—At the beginning of the fiscal year the work of jetty extension was going on in all its ramifications. In July, 1893, the tramway was extended 288 feet, 750 linear feet of center mattress and 816 linear feet of side mattresses were put in position, and 10,368 tons of rock were received and deposited.

This tramway extension carried the work as far as it was deemed safe with the existing appropriation, and it ceased with the total length attained of 9,520 feet.

The mattress work went on until October, 1893, when it was finally completed for the length of tramway constructed. After this was finished the work done consisted in receiving and placing stone in the jetty, which continued throughout the year. In order to facilitate the impounding of sand in the vicinity of the old swash channel, a sand catch was made by planking up the tramway between bents 209 and 281. Old and cheap lumber was used for this purpose. The result was very satisfactory. A high bank was established which forms the basis for a high-level accumulation seaward at a sufficient elevation for the establishment of plant growth.

During the year a survey was made of the south heads with a view of determining the proper location for the wharf and approaches to the south jetty. The result of the survey was to show the great difficulty and expense which would be encountered in carrying the tramway approach over the heads, and it was finally determined that the cheapest and best location would be along the bluffs at the entrance to the bay. This is necessarily exposed to heavy seas and to drift, but the aggregate expense of constructing, protecting, and repairing it will be less than would be the case if the line over the heads were adopted. This line over the heads would involve crossing a summit 116 feet above high water, and for permissible grades would require a cutting of 50 feet or a great development with sharp curves.

The plat herewith shows in a heavy broken line the location finally fixed upon for the south jetty and its wharf and approach.

During the fall of 1893 a great cigar-shaped raft of piles was constructed in Coos Bay to be taken to San Francisco, Cal. This raft was 612 feet long and drew 16 feet of water. It contained 3,500 piles from 60 to 100 feet long, bound together with fifty stout chains.

On November 19 an effort was made to take this raft to sea, but owing to delays it did not get upon the bar until the tide had fallen considerably. While being handled by the tugs it took a sheer and grounded on the south spit just inside the bar. Here it was left, and during the high night tide it floated off and across the channel, around the end of the jetty, and lodged against the tramway, where, under the action of the waves, it acted as a battering ram and knocked out a number of piles. This continued until November 22, when under favorable conditions it was towed off and taken into the bay for repairs. The damage done to the tramway by the raft cost, to repair, about $700.

The raft was afterwards safely taken to sea, but while being towed to San Francisco was wrecked by a storm off Cape Mendocino and the piles scattered all along the coast.

Besides the regular jetty rock, which is required to be of large size, there was received from the contractors during the year 981.3 tons of small rock, which was purchased at 25 cents per ton. This was used to protect the shore in the vicinity of the wharf and root of the jetty.

After the stone contractor had delivered the maximum amount called for by his contract, 150,000 tons, it was found that the funds available would permit 12,000 tons additional to be purchased, which was accordingly done at the contract price.

The steamer *Gen. H. G. Wright* was kept in commission all the year for handling materials and transporting men and supplies.

The following are the amounts of the principal materials used in the jetty construction received for each month during the year.

The rock cost 53½ cents per ton delivered on scows at the jetty wharf.

The brush cost from $1.75 to $2 per cord on barges.

The piles cost 4½ and 4¾ cents per foot in the boom at Yarrow.

The poles cost 17½ cents each on barges.

The small "one-man rock" cost 25 cents per ton on scows at the jetty wharf.

Month.	Rock.	Brush.	Piles.	Poles.	Small rock.
1893.	*Tons.*	*Cords.*	*Feet.*		*Tons.*
July	10.368.4	314.5	11,218	247	
August	11,747.7	473	8,422	1,718	
September	14.164.4	377		596	
October	12.558.6				
November	10,162.4				
December	7,790.7				
1894.					
January	5,944.3		3,833		
February	6,509.3				
March	9,455.2				
April	13,401.1				236.6
May	10,823.7				744.7
June	3,433.6				
Total	116,359.4	1,164.5	23,473	2,561	981.3

The following represents the mattress work done up to the end of the fiscal year.

All the mattresses are 20 feet wide, so where a center mattress and one side mattress are placed the mattress foundation is 40 feet wide, and where a center mattress and two side mattresses are placed the foundation is 60 feet wide.

The center mattresses, 3 feet thick, are on the portion of the jetty nearest the point of beginning. In the outer deep-water portion these center mattresses were invariably 5 feet thick.

	Feet.
Center mattress, 3 feet thick, 20 feet wide, length	3,360
Center mattress, 5 feet thick, 20 feet wide, length	4,864
Center mattress, 5 feet thick, 20 feet wide, on groin, length	280
Channel side mattress, 3 feet thick, 20 feet wide, length	8,464
Sea side mattress, 3 feet thick, 20 feet wide, length	2,064
Shore revetment mattress, 3 feet thick, 20 feet wide, length	760

I send herewith a plat which gives a longitudinal profile of the jetty tramway and enrockment, a typical cross section near the outer end of the jetty, and an index plat showing the mattress location, etc. The tramway is constructed as shown and as has been previously described in former reports on the Coos Bay improvement. In one important particular, however, a departure from old methods has been made; this is the omission of sway braces in the most exposed part of the tramway. In this outer portion piles 80 feet long were used; driven 25 to 30 feet into the sand, they stood up in water and air about 50 feet. The tramway when fully completed swayed greatly under the action of the waves. It was believed that such braces as could be used conveniently would tend to weaken rather than strengthen the tramway by exposing a greater surface to the action of the waves, and consequently they were omitted. Additional strength was given to the tramway by double drift bolting the caps to the piles, and by tying the caps to the outer piles by iron straps. The tramway as constructed has stood without accident.

No additional efforts were made during the year toward the reclamation of the sand dunes and flats of the North Spit. The only success which we have had with anything has been with the Holland grass, the roots of which were procured from San Francisco. This has grown and thickened, and will soon be capable of subdivision into smaller roots and the planting of larger areas.

For further details of operations, attention is invited to the report of Mr. J. S. Polhemus, assistant engineer, herewith.

Recommendations and remarks.—With the existing appropriation it was considered advisable to stop the tramway of the north jetty 848 feet short of its predetermined entire length, in order that the portion built could more certainly be secured by the enrockment.

When work starts under a new appropriation the first thing to be done will be to complete the tramway to the end, and all money remaining will then be expended in bringing the enrockment to its required condition, or as near thereto as practicable.

It is in the highest degree in the interest of economy that this enrockment should be completed during the life of the pile tramway, and it is on this account that liberal appropriations for this work are specially recommended.

The completion of the Coos Bay, Roseburg and Eastern Railroad from the bay to Coquille City and Myrtle Point, on the Coquille River, adds much to the commercial importance of Coos Bay, making, as it does, the whole Coquille country, with its wealth of coal, lumber, and agricultural resources, more or less tributary to the bay. The fine results accomplished by the north jetty in deepening the bar channel temporarily indicate very clearly what may be expected permanently when both jetties are completed. The good accomplished can only be partial until both jetties are acting together.

An appropriation of $600,000 is recommended as the amount which can be profitably expended during the next fiscal year.

Future operations.—Work is in progress in overhauling the plant and putting it in order, so that when the new appropriation is available there will be no delay in going on with the work. It is probable that, with the new appropriation, work will be confined to the north jetty.

The report of Mr. J. S. Polhemus, assistant engineer in local charge of the work, is herewith:

Money statement.

July 1, 1893, balance unexpended	$123,993.76
June 30, 1894, amount expended during fiscal year	116,037.89
July 1, 1894, balance unexpended	7,955.87
July 1, 1894, outstanding liabilities	2,500.00
July 1, 1894, balance available	5,455.87
Amount (estimated) required for completion of existing project	2,131,412.20
Amount that can be profitably expended in fiscal year ending June 30, 1896	600,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. J. S. POLHEMUS, ASSISTANT ENGINEER.

EMPIRE CITY, OREG., *June 15, 1894.*

CAPTAIN: I have the honor to submit the following report of operations on the work of improving the entrance to Coos Bay and harbor, Oregon, for the fiscal year ending June 30, 1894.

At the date of the last annual report work on the north jetty was in full progress, and it so continued without intermission throughout the year until June 12, 1894, when active operations ceased for lack of funds, the appropriation being nearly exhausted.

The principal features of the work in the past year consist of a slight extension of the jetty tramway seaward, the placing of center and side foundation mattresses for more than a quarter of a mile at the outer end, but chiefly in receiving and placing on the jetty nearly 121,000 tons of rock.

No important additions were made to the plant. The work on the jetty was performed by hired labor, the men working eight hours per day and being subsisted by the Government at an average cost of 42 cents per day's ration. The number of the total force at the North Spit, including foremen, mechanics, and laborers, varied from 60 to 30 men.

Most of the rock was furnished under contract and the other materials of construction purchased in open market, including 11,869 tons of rock purchased in open market from Mr. Kern, at 53½ cents per ton, and delivered in May and part of June; also 981.3 tons of "one-man rock" and quarry spalls, purchased from John Kiernan at 25 cents per ton.

Extension of jetty tramway.—The north jetty tramway was extended in the fiscal year from trestle bent 577 to bent 595, a distance of 288 feet, and on July 11 the pile-driver was hauled in and dismantled, as it was judged as much tramway had been built as could be properly secured before the storms of winter would be upon it.

Fifty-three trestle bents, or 848 feet, remain to be built to complete the project, as far as the extension of the north jetty is concerned.

All the necessary materials for this, including piles and timbers and rails, have been purchased and paid for and are stored on the gridirons ready for use. The jetty pile-driver is equipped and in good order for service.

The depth of water throughout the last 752 feet varied from 20 to 26 feet at mean lower low water.

The tramway was built precisely as described in the last annual report. The bents contain 4 piles each, and are spaced 16 feet apart, the caps are 12 by 12-inch square fir timbers, 22 feet long, driftbolted with two 24-inch bolts of 1¼-inch round iron in each pile. Four longitudinal 12 by 16 inch by 32 feet fir stringers, fastened to the caps by 1-inch driftbolts, carry the 30-pound steel track rails.

The gauge is 3 feet and there are two tracks 13 feet apart, center to center. The elevation of the outer end is 27 feet above mean lower low water.

The piles used are of fir, 16 to 22 inches in diameter at the butt, and about 75 feet long. They were hydrauliced into the sandy bottom by two 1½-inch water jets supplied by the 10 by 6 by 10-inch Worthington steam pump attached to the pile-driver, the weight of the 5,000-pound hammer assisting in settling them in place. They were not sawed off, but driven carefully to grade.

No sway braces have been used and the tramway does not appear to require any. The piles were purchased in open market from John Yoakam, at from 4 to 4¾ cents per linear foot, according to the length.

The timber was purchased from the North Bend mill and from E. B. Dean & Co., at $9 per M, delivered free on board scow at mill. This portion of the tramway cost $3.95 per linear foot.

The caps of the tramway for the outer 2,000 feet were double bolted, and further secured by two straps of ⅝-inch by 2½-inch flat iron to each bent passing over the caps and spiked to the piles.

Brush mattress work.—The center foundation mattress, 5 feet in thickness and 20 feet wide, was laid from bent 494 to bent 595 (the outer end), a distance of 1,616 feet.

The channel side mattress 3 feet by 20 feet was laid from bent 500 to the end, a distance of 1,520 feet; also a side mattress on the other side from bent 490 to bent 595 (the end), a distance of 1,680 feet.

All mattress work closed September 16, 1893.

The center mattresses were built on grillages of fir poles suspended from the track stringers and lowered and sunk to place with small rock.

The side mattresses were built on flat cars, hauled out, dumped, and sunk in place with small rock.

Considerable difficulty was experienced in getting the mattresses safely down in the deep water, especially when the sea was the least rough. They would sometimes turn over if not loaded exactly right and be carried away or broken up by the sea. We probably lost in this way altogether a dozen mattresses 20 feet long.

The fascines composing the mattresses were of fir brush, about 1 foot in diameter and 20 feet long, bound with 4 ties of three-ply bale rope. They were purchased in open market, chiefly from C. A. Metlin and William Ross, and cost $1.90 per cord free on board our scows, which were towed to the works by the Government steamer *Gen. H. G. Wright*.

The poles were obtained in the same way as the brush, and cost 17½ cents apiece. They were of fir, 24 feet long and 8 inches in diameter at the butt, and were spaced 4 feet apart in the mattresses.

The mattresses were lashed together with 12-thread manila rope. The center mattresses were generally sunk in sections as long as two and three trestle bents.

The cost was $1.78 per linear foot for center mattresses and $1.65 per linear foot for side mattresses, including materials and labor.

Rock supply.—Daniel Kern, under his contract of September 19, 1892, delivered to us in the fiscal year 406 scow-loads of rock, which weighed about 109,000 tons. The contract price was 53¼ cents per net ton delivered at the works, he using our scows.

He did the towing with the small propeller *Tonquin*, and obtained the stone from the Government quarry, purchased the preceding year from Mr. Anson Rogers, on South Coos River, 1 mile above the forks and 19 miles from our wharf. The quarry turned out very well. The rock is a soft gray sandstone of a specific gravity of 2.35, and according to contract was delivered in pieces averaging 2 tons each in weight, the largest piece weighing as much as 12 tons.

The rock was measured by displacement of scows, the maximum load being about 300 tons, but the average load for all the scows was about 270 tons. Mr. Kern operated 3 derricks at the Rogers quarry, and for a short time one at a quarry leased by himself from Mr. Carpenter, about 1 mile farther up the river.

He delivered the last load May 6, 1894, and completed his contract of the 150,000 tons in a very satisfactory manner.

At the close of Mr. Kern's contract, there being sufficient funds available, we purchased an additional 11,869 tons of rock from him in open market at the same price. We also purchased in open market from John Kiernan, 4 scow loads of quarry spawls (981 tons of "one-man rock"), which was used to enrock shore protection mattresses and the 2 jetty groins.

At our receiving wharf all the rock was hoisted with 2 derricks, with which we have unloaded as much as 800 tons in eight hours. The rock received in the fiscal year was run out on cars and dumped by the 2 brakemen on the jetty, from trestle bent 300 to the outer end.

At the present writing the crest of the jetty enrockment is not below ordinary high tide, as far as bent 300; between that and bent 450 its elevation is equal to half tide; beyond and to the end the enrockment is more or less above mean lower low water (see profile herewith).

It cost for labor and fuel about 9¼ cents per net ton to unload and dump the rock, not including the first cost of plant or general superintendence.

Plant.—Our plant consisted of the same engines, scows, and appliances as enumerated in last year's report, viz, 1 revolving jetty pile-driver, originally from the mouth of the Columbia River, and used to build the jetty tramway; 1 small steamer, the *Gen. H. G. Wright*, of 45 tons, employed in towing scows of brush, lumber, and coal, and rafts of piles, and to tend on the works generally, 2 11-ton locomotives, 20 geared dump cars for carrying the rock, 6 flat cars, 4 push cars, 1 hand car, 2 15-ton derricks on the receiving wharf, and 2 powerful double-cylinder Lidgerwood hoisting engines, 7 large rock scows, and 4 smaller scows for brush and lumber, besides small boats, anchors, chains, ropes, and multifarious tools and appliances. A 12-foot Aermotor windmill furnished the water supply from a well in the sand near by. It would cost to replace the plant new about $75,000. It is in fairly good condition, but I estimate will require about $2,500 to put it in complete order; this is now being done and will occupy us for a couple of months.

The number of stone scows being too small for most efficient work, the 3 stone scows from the Siuslaw River were borrowed from that work after active operations ceased there, and were towed around to Coos Bay by the tug *Roberts* in August last, and after receiving a recalking, were added to our fleet.

We used 555 tons of Coos Bay coal for fuel during the year, at $3 per ton on board scows at the bunkers, and 300 ricks of short stove and engine wood at $1.50 per rick.

Reclamation of sand dunes.—No work was attempted last year toward the reclamation of the sands of the North Spit. Nearly all of the young marine pine and willow trees died. The Holland grass (*Arundo arenaria*), planted two and three years ago, continues to grow and spread slowly, and promises to be the most effectual means of accomplishing the work of reclamation when undertaken on a sufficiently extensive scale.

Condition of the bar and general results accomplished.—The end of the jetty is now at bent 595, about 9,520 feet from the receiving wharf, and the crest of the enrockment is nowhere below the plane of mean low tide. Of course the ridge of enrockment is not yet brought to its full width on top and is much too peaked. It will no doubt beat down considerably under the influence of the breakers.

The bar channel runs in a westerly course straight to sea, and has a least depth at mean lower low tide of about 20 feet, being by far the best depth recorded here.

When Lieut. Francis R. Shunk was here last, 23d of February, we took soundings on the bar from our steamer *Gen. Wright*, and found a least depth of 22½ feet at mean lower low water.

It is a common occurrence for vessels drawing 16 feet to be towed out on half tide, and on June 12 the barkentine *Tam O'Shanter* was towed to sea loaded with piles and drawing 18 feet.

The bar has only moved slightly seaward, but there has been a vast accumulation of sand to the north of the jetty, which continues to increase. The sands in the bay have changed very little.

Miscellaneous.—The San Francisco Bridge Company constructed last summer a large cigar-shaped raft of 3,500 long piles, bound together with heavy chains. It was 620 feet long, 45 feet beam, and drew 16 to 17 feet of water. In attempting to tow it to sea on November 18 it stuck on the south spit. The next morning found it behind and against the jetty on the north side, with its inner end at bent 426.

It injured 57 trestle bents of our tramway by breaking off 71 piles. It threatened much more serious damage, but fortunately was towed out of its perilous position by two tugs November 22. It was again towed to sea December 16, but broke up and went to pieces on its way down to San Francisco.

Eighty new piles, 50 feet long, were purchased, and on February 23 we commenced to repair the damage to the tramway, which we finished March 21. We were very successful in driving the new piles from 6 to 17 feet through the enrockment with our jetty driver. We replaced 72 piles and repaired the tramway as good as new at an expense of about $700.

I am glad to be able to report no accidents on the work during the year except the sinking of a leaky scow at the North Spit wharf, with part of a load of stone; the scow was raised without much loss and the stone saved.

No men were injured on the works during the year.

Mr. John Eldridge was the overseer; Mr. Morton L. Tower, timekeeper and general assistant; Mr. Charles E. Getty, foreman of pile-driver, and Major Morton tower inspector at the quarry. I have to thank them, and all the force, for attention to duty during the past year.

In closing a summary of the total work accomplished on the North Spit may be of interest.

Two appropriations have been made for the new project to date, viz:

By act approved September 19, 1890	$125,000
By act approved July 13, 1892	210,000
Total	335,000

With this, work was first commenced on the North Spit in the spring of 1891. We have to date accomplished the following:

Purchased and installed a good and efficient plant and bought a good quarry site; built a receiving wharf and erected the necessary buildings for the accommodation of the crew, etc.; extended the jetty tramway from the wharf about 9,500 feet, or within 848 feet of the projected end of the north jetty; laid all the necessary brush mattresses throughout this distance, including 7,872 linear feet of center mattresses and 10,528 linear feet of side mattresses, consuming 5,975 cords of brush and 10,972 poles.

We have received and dumped on the jetty the following amount of rock:

	Tons.
From W. E. Baines	23,923
From Daniel Kern	161,869
From John Kiernan	981

I send the following sketches to accompany this report, viz: A map showing jetty construction and shore lines to date, a profile of the jetty, and a cross section at bent 560.

Very respectfully,

J. S. POLHEMUS,
Assistant Engineer.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

PLAN OF IMPROVEMENT

To construct two brush and stone Jetties converging upon and crossing the crest of the bar, at a distance apart of 1500 ft.; the North Jetty resting upon the south end of the North Spit, and the South Jetty resting upon Coos Head.

APPROPRIATIONS	$
Act of March 3. 1879	40,000
" " March 3. 1881	30,000
" " Aug. 2. 1882	30,000
" " July. 5. 1884	30,000
" " Aug. 5. 1886	33,000
" " Aug. 11. 1888	50,000
" " Sep. 19. 1890	125,000
" " July. 13. 1892	210,000

annual report, 1894. Thos W Symons.

Captain Corps of Engineers.

The Friedenwald Co., Photo-Lith., Balto., Md. **Eng. 53 3.**

THE FRIEDENWALD CO., PHOTO-LITH., BALTO MD. **Eng. 53 3.**

COMMERCIAL STATISTICS.

Coos Bay is in the collection district of southern Oregon. Empire City, on the bay, is the port of entry. The nearest light-house is at Cape Arago, on the south side and west of the entrance.

The following returns are furnished by Mr. J. S. Polhemus, assistant engineer in charge of works at Coos Bay, and are for the fiscal year ending June 30, 1894:

Arrivals and departures of vessels.

Coastwise steam and sail vessels.	Number.	Aggregate tonnage.
Arrivals	186	64, 922. 43
Departures	185	64, 794. 84
Totals	371	129, 716. 27

Of the above arrivals 88 were sailing vessels and 98 were steam vessels.

Passengers arrived by sea	1, 167
Passengers departed by sea	1, 138

Vessels built.—Schooner *Gen'l J. M. Siglin*, 90 tons register, built at Marshfield.

Exports and imports.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.		EXPORTS—continued.	
Apples ... tons	1. 1	Pickets ... tons	39. 9
Butter ... do	65. 8	Pork (barrels) ... do	. 8
Beef in barrels ... do	1. 5	Potatoes ... do	729
Broom handles ... do	32	Piles (5, 967)	15, 000
Box material ... do	233. 2	Poles, telegraph	125
Borax ... do	50	Salmon (barrels)	48. 4
Boat spars ... number	37	Salmon (cases)	70
Coal ... tons	35, 665	Specie	$19, 022. 13
Cheese ... do	55. 5	Wool ... tons	26. 5
Chickens ... dozens	8		
Cranberries ... tons	16	Total ... tons	100, 576. 1
Chittim bark ... do	6. 2		
Eggs ... do	1. 3	IMPORTS.	
Firewood and matchwood ... do	2, 263		
Hogs (live) ... do	25	General merchandise ... tons	7, 545
Hoops and staves ... do	153. 5	Steel rails ... do	929
Hides and furs ... do	4. 6	Salmon cans (empty) ... do	102
Laths ... do	769. 8	Stone barges ... number	3
Leather ... do	64	Specie	$10, 697
Lumber (21,763,455 feet, B. M.) ... do	43, 526		
Miscellaneous freight ... do	1, 603	Total ... tons	8, 576

SUMMARY.

	Tons.	Estimated value.
Total exports	100, 576. 1	$974, 494
Total imports	8, 576	473, 801

U U 4.

IMPROVEMENT OF UMPQUA RIVER, OREGON.

Description of original condition.—Just below Scottsburg, the head of navigation on the Umpqua River, are five sandstone bars or ledges, 12 to 15 feet wide and submerged from 1 foot to 2 feet at low tide on a low-river stage. They are separated by pools about 150 feet wide and from 5 to 10 feet deep at low water.

Plan of improvement.—The honorable Secretary of War having authorized the expenditure of the balance remaining of the appropriation of March 3, 1871, viz, $4,685.89, in improving the river below Scottsburg, a project was submitted and approved in 1885 for making, at an estimated cost of $4,056, a channel 50 feet wide and 3 feet deep at low water through the rock ledges above described by drilling and blasting the rock and removing the broken pieces to deeper water in the pools.

In September, 1889, a survey was made of the Umpqua River from Scottsburg to its mouth, and a project prepared for its improvement, which was submitted January 16, 1890. This project provides for the removal of rock bowlders and ledges in the wharf basin at Scottsburg and below this basin with the view of opening a channel way 50 feet in width and 4 feet in depth at low water. The project was approved under date of October 28, 1890.

The estimated cost of completing the project was $9,000. This cost has been reestimated at $15,000.

APPROPRIATIONS.

Act of—	
March 3, 1871	$22,500
August 11, 1888	2,000
September 19, 1890	9,000
Total	33,500

Amount expended to June 30, 1893.—The amount expended on the project to June 30, 1893, was $14,245.16.

Results obtained to June 30, 1893.—A large amount of rock had been removed and the work was being vigorously prosecuted, when the river suddenly rose and became so muddy that it had to be left in an uncomplete condition.

Amount expended during the fiscal year ending June 30, 1894.—There was expended during the fiscal year ending June 30, 1894, the sum of $1,233.15.

Results obtained to June 30, 1894.—There were removed from the reef below Scottsburg 252½ tons of rock, when the appropriation being about exhausted work ceased.

The channel 4 feet deep and 50 feet wide has not yet been completed.

Report of operations.—The work of improving the Umpqua River was placed in charge of Lieut. Graham D. Fitch, Corps of Engineers, who arrived in Scottsburg July 26, 1893, and organized his force and proceeded with the work of rock removal.

He removed 252½ tons of rock by blasting, hoisting on scows with the help of a diver, and depositing upon the river bank. When this was done it was found to be necessary to suspend operations for financial reasons, although the work was not completed.

Lieutenant Fitch made a survey of the rocks and reefs along the projected channel and found that there was about 500 cubic yards yet to be removed before the channel could be considered as completed.

Recommendations and remarks.—From the foregoing it is evident that the money appropriated for this work, and which corresponds in amount with the estimates, is exhausted and the work is still uncompleted.

The original estimate for the work, dated January 16, 1890, was as follows:

Removal of 1,200 cubic yards of rock, at $6 per cubic yard	$7,200
Contingencies, superintendence, etc	1,800
Total	9,000

Up to the present time 700 cubic yards of rock have been removed at a cost of $8,788.42, or about $12.50 per cubic yard.

There are yet 500 cubic yards to be removed to provide a channel 50 feet wide and 4 feet deep at low water.

It is estimated that it will cost $12 per cubic yard to remove these 500 yards, or $6,000.

I am compelled, therefore, to make this supplementary additional estimate of $6,000 to complete the project adopted for the improvement of the Umpqua River.

The discrepancy between the actual cost of doing the work and the estimated cost, necessitating this supplemental estimate, can only be explained by stating that in making the original estimate the difficulties in the way of doing the work were not fully appreciated. The work is situated in a remote region difficult of access, to which it was expensive to supply men, materials, and tools, and devoid of facilities to aid in the operations. There was about 4 feet of tide to contend with, and all the rock removed had to be handled by a diver. The work has to be done when the water is clear, and any storm in the watershed of the river interfered with operations by muddying the water. The work was well under way at one time when the river rose suddenly and became permanently muddy for the season, compelling a cessation of operations. This caused the dispersal of the entire outfit, the storage of tools and supplies, and the renewal of all operations another year.

The cost of collecting men, tools, and supplies, and dispersing and disposing of them on two occasions was an important function in the discrepancy between the estimated and actual cost.

The work on the Umpqua is left in such a condition that that which is done can be of little benefit until the whole channel is completely excavated. I would therefore recommend that $6,000 be appropriated to complete the work on the Umpqua River.

Money statement.

July 1, 1893, balance unexpended	$1,443.46
June 30, 1894, amount expended during fiscal year	1,233.15
July 1, 1894, balance unexpended	210.31
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

The following is the report of Lieut. Graham D. Fitch, Corps of Engineers, who was in local charge of the work:

REPORT OF FIRST LIEUT. GRAHAM D. FITCH, CORPS OF ENGINEERS.

PORTLAND, OREG., *October 4, 1893.*

CAPTAIN: I have the honor to submit the following report of operations on the improvement of the Umpqua River during the past summer:

On July 26 I arrived at Scottsburg. A week was consumed in the preliminary operations of getting the plant from Gardiner to Scottsburg, hiring men and scows, erecting derrick, assembling hoisting engine, etc., and on August 3 active work was begun.

When operations ceased in November, 1891, a large number of holes, which had been drilled, had not been fired. These holes had been left plugged and were found without difficulty. It was therefore unnecessary to do any drilling until August

24. By that time 249 of these holes had been loaded with 852 pounds of dynamite and fired in several blasts by fuse and sympathetic detonation, and 208.5 tons of rock had been raised by means of a diver and a steam hoisting engine and dumped by hand along the river bank. The time from August 24 until September 1 was spent in drilling with an Ingersoll steam drill to an average depth of 4 feet, 69 holes in a reef which had been partly drilled in 1891. One hundred and thirty-two holes in this reef (63 drilled in 1891) were then loaded with 460 pounds of dynamite and the reef blasted. Ninety pounds of dynamite were used afterwards in breaking up fragments too large to be lifted. Forty-four tons of rock had been removed from this reef and dumped, making 252.5 tons in all, when orders were received on September 13 to close operations immediately on account of insufficient funds. This was done at once, and, in accordance with your instructions, everything worth transporting was taken to Gardiner and arrangements were made to have it shipped to Coos Bay at the first opportunity. A few things were stored with Mr. P. P. Palmer, at Scottsburg.

In order to determine the present condition of the channel a survey was made shortly before operations ceased. Having no surveying instruments I adopted the following method: At intervals of 100 feet along the river bank I drove stakes and marked their approximate positions on the map of 1889. Opposite each of these stakes, and wherever deemed advisable, opposite points midway between them, I took at intervals as nearly equal as possible a series of soundings across the river from a boat which was rowed at a slow and uniform rate. To obtain a greater number of soundings in the channel itself I then established two lines of buoys, each 25 feet from the center of the channel, and sounded along these lines and along the center of the channel.

A gauge agreeing with the gauge at the Scottsburg wharf and established at a convenient point was frequently read, and all soundings, before being plotted, were reduced to the zero stage or plane of low water.

When I began operations I expected to find, in agreement with statements in the office records at Portland, that all the reefs had been removed, and that the only work required to complete the project consisted in the removal of points of rock and edges of cuts. This was not the case, however, and, as reported above, no work was done this season except on reefs (previously drilled wholly, or in part, but not blasted); and owing to the early cessation of work, rendered necessary by lack of funds, only a portion of the rock from the last reef blasted could be raised and dumped. One reef, marked "drilled" on the map of 1889, and which I am told was drilled eight years ago, is still intact. This reef is marked "A" on the accompanying map. Above "A" to the Scottsburg wharf the channel fulfills all requirements. From "A" for a distance of about 1,200 feet downstream there are only a very few places that will have to be deepened; then for about 400 feet the obstructions are quite numerous, and consist partly of rocks that will require to be blasted and partly of loose rock blasted this season but not removed from the channel.

Below this latter stretch the channel again improves, though a number of places need deepening. Altogether about 500 cubic yards of rock will have to be removed, if a channel 50 feet wide and 4 feet deep is to be secured.

Very respectfully, your obedient servant,

GRAHAM D. FITCH,
First Lieut., Corps of Engineers.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Umpqua River is in the collection district of southern Oregon. Empire City, Coos Bay, is the nearest port of entry. The nearest light-house is situated about half a mile south of the entrance; it is a brick structure, and but recently completed.

The following returns are kindly furnished by Mr. O. B. Hinsdale, of Gardiner, Umpqua River, Oregon, and are for the fiscal year ending June 30, 1894:

Vessels arrived and cleared.

The number of vessels of all descriptions crossing in over the bar during the year was 73; the number crossing out was 73; of this number 37 were steamers and 36 were sail vessels.

Maximum draft of loaded vessels was 14.6 feet.

Exports and Imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
	Tons.			*Tons.*	
Lumber (10,000,000 ft., B. M.)	20,000	$130,000	General merchandise	1,000	$100,000
Laths	750	7,500	Machinery for sawmill and cannery	25	10,000
Wool	1	300	Agricultural implements	75	5,000
Leather	5	3,000	Salmon, canning material, including box stuff, cans, nets, and twine	50	25,000
Hides and furs	4	2,000			
Grain	235	5,750			
Hops	2	450			
Salmon, canned	420	60,000			
Potatoes	20	400	Total	1,150	140,000
Fruit	3	100			
Butter and cheese	5	2,000			
Chittim bark	5	400			
Salt pork and beef..barrels	60	600			
Total	21,510	212,500			

Umpqua River traffic.

Steamer *Juno* (propeller), 22.28 registered tonnage, runs between Gardiner and Scottsburg:

Passengers carried during the year		2,076
Freight carried during the year	tons..	1,200

Steamer *Restless* (stern-wheeler), 101.02 registered tonnage, runs between Gardiner and Sulphur Springs:

Passengers carried during the year		847
Freight carried during the year	tons..	600

SUMMARY.

Total exports (21,510 tons)	$212,500
Total imports (1,150 tons)	140,000

There were no vessels built on the river during the past year.

U U 5.

IMPROVEMENT OF MOUTH OF SIUSLAW RIVER, OREGON.

Description of original condition.—The Siuslaw River enters the ocean in the midst of a vast, shifting, sandy beach, without any headland or fixed point to determine the location of the entrance channel.

The unconfined channel has a range of about 1 mile, over which it wanders in making connection with the ocean. In consequence of this wandering and spreading out of the outgoing and incoming waters, the bar at times shoals very badly, while at other times it has a depth equal to the controlling depth inside the entrance. The depth in the bar channel varies from 5 to 12 feet at low water, and the channel changes very much in position and direction.

At times a channel is developed inside the bar, which runs nearly parallel with the coast. This channel is narrow, badly defined, and dangerous, as boats have to pass through it in the trough of the sea. At other times there are two channels.

Plan of improvement.—The plan of improvement for the entrance to the Siuslaw is to confine the outgoing and incoming waters between high tide stone jetties, so located as to direct the currents upon the ocean bar in a direction practically perpendicular to the coast, these jetties to converge till they are 600 feet apart at the crest of the bar.

The location of the jetties is approximately shown upon the map published with the annual report from this office for 1891 (Report of Chief of Engineers, 1891, page 3178) and for 1893 (Report of Chief of Engineers, 1893, page 3346).

The north jetty leaves the mainland about half a mile north of Cannery Hill, and is 4,500 feet long. The south jetty extends from the end of the sandy peninsula and is 3,200 feet long.

The wharf for the north jetty is located just below Cannery Hill, and the approach to the jetty is 3,000 feet long.

The wharf for the south jetty is opposite the north jetty wharf, and the approach is 2,400 feet long.

The jetties are to be built of brush and stone from a pile tramway. The estimated cost of the work was $700,000.

APPROPRIATIONS.

Act of—	
September 19, 1890	$50,000
July 13, 1892	20,000
Total	70,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $65,044.70.

Results obtained to June 30, 1893.—The plat published with my last year's report indicates the extent to which the work of jetty building had been carried. As all work stopped with the close of the fiscal year 1892–'93, this shows that the work had to stop just as the real jetty construction commenced. The work has not progressed sufficiently far to produce any results of importance on the bar.

Amount expended during the fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $3,606.38.

Results obtained to June 30, 1894.—No work upon the project was done during the year and there was no advancement of the project. The only results were of a negative character, the partial destruction of the tramway and wharf by wind, wave, and slides.

Report of operations.—At the close of the fiscal year, June 30, 1893, all active work stopped and the plant was put in good order for the long period of idleness until another appropriation should become available.

Everything of an easily removable character was left at the mouth of the river under charge of a watchman. The scows were left at the quarry under charge of another watchman.

These scows were afterwards taken to Coos Bay for temporary use, and the services of the quarry watchman dispensed with.

During the winter of 1893–'94, the jetty tramway suffered considerable damage, chiefly where it was built against the side of the sandy bluff. In this portion short pieces of piling were used with slight penetration. During the winter the side of the bluff has been washed away and the tramway in many places left without support. The north track between bents 111 and 120 sags, until at bent 115 it almost touches the ground.

Comparatively little damage has been done by drift. From bent 180 to bent 197, the space between the piles is filled with logs of all sizes which are afloat at high water. In this portion only one pile has gone, and one is knocked loose. Altogether there have been (according to Lieutenant Shunk's inspection in March, 1894) 85 piles carried away or damaged.

The windmill erected to furnish a water supply was blown down and destroyed.

The channel has moved much to the north of its position in June, 1893, and is more nearly in the position shown by the survey of September, 1891. The opening over the bar changes after each storm.

Recommendations and remarks.—When the work at the Siuslaw was commenced the channel was in its southern position. It has been working north ever since, until now it is nearly in its most northerly position. When work is resumed we will, unless in the meantime the channel shifts to its southerly position, be confronted with the necessity of driving the jetty directly across the main entrance channel.

A good, and for the time being sufficient, plant being on hand, all auxiliary structures built, the quarry opened and in working order, any further appropriations, after repairing the ravages of time and the elements, will be available for jetty construction *per se*.

It is estimated that the sum of $50,000 can be profitably expended upon the project during the fiscal year ending June 30, 1896.

Money statement.

July 1, 1893, balance unexpended	$4,955.30
June 30, 1894, amount expended during fiscal year	3,606.38
July 1, 1894, balance unexpended	1,348.92
July 1, 1894, outstanding liabilities	600.00
July 1, 1894, balance available	748.92
Amount (estimated) required for completion of existing project	630,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The Siuslaw River is in the collection district of Yaquina. The nearest port of entry is Yaquina City on Yaquina Bay.

The nearest light-house, recently completed, is at Hecata Head, about 8½ miles to the north of the entrance to the Siuslaw River.

The following returns are furnished by Mr. James Fairweather, of Florence, Lane County, Oreg., and are for the fiscal year ending June 30, 1894:

Arrivals and departures of vessels.

Coastwise steam and sail vessels.	Number.	Aggregate tonnage.
Arrivals	59	3,477
Departures	58	3,407
Total	117	6,884

Of this number 74 were steam vessels and 43 were sail vessels, the latter bringing in merchandise and clearing with lumber, and the former bringing in merchandise, supplies, etc., and clearing with produce and cannery output.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
	Tons.			*Tons.*	
Lumber (2,685,000 feet, B. M)	5, 370	$32, 220	General merchandise	911	$36, 440
Salmon (cases)	500	45, 000	Hardware	140	6, 750
Salmon (barrels)	140	12, 800	Flour and feed	250	10, 000
Hides and furs	6	950	Cannery supplies	237	17, 680
Wool	5	1, 000			
Chittim bark	42	2, 520	Total	1, 538	70, 870
Potatoes	32	320			
Butter	2. 5	1, 000			
Miscellaneous	415	41, 500			
Total	6, 512. 5	137, 310			

SUMMARY.

	Tons.	Estimated value.
Total exports	6, 512. 5	$137, 310
Total imports	1, 538	70, 870

River traffic.—The following steamboats make daily trips from Florence to Acme, Point Terrace, and Seaton, 20 miles and return, but during winter months biweekly trips only are made:

Steamer *Coos*, draft 3 feet, registered tonnage 53.5.
Steamer *Mink*, draft 2 feet, registered tonnage 5.
Steamer *Lillian*, draft 6 feet, registered tonnage 25.5.

The two former boats carry merchandise, produce, and passengers, and average about 2 tons each trip. The *Lillian* is engaged principally in towing on the river. The bar service is attended to by the *Robarts*.

Vessels built during year.—One schooner was built at Florence for the San Francisco Bay trade. She will register about 140 tons and has not yet been named. She is now loading for the latter port.

New industries.—One sawmill built since date of last report; its capacity is 25,000 feet, B. M., per day.

U U 6.

IMPROVEMENT OF YAQUINA BAY, OREGON.

Description of original condition.—The usual prevailing depths over the bar at low water before improvement were from 7 feet to 8 feet. Three distinct channels existed, known as the north, middle, and south channels. The south channel was the one mostly used, but was rendered dangerous by the presence of rocks. The middle channel, though free from rocks, was usually the shoalest of the three, and so was little used. The north channel, besides being long and tortuous, was so studded with rocks as to be considered unnavigable. Owing to the shifting nature of the bar these channels were constantly changing both in position and depth.

The mean rise of tide was 7.1 feet.

Plan of improvement.—The project, adopted in 1881, was to run out a dike or jetty on the south side of the entrance, so as to cause the south channel to shoal up and the flow to be deflected northward, with a view to opening and maintaining the central channel with a least depth of 17 feet at high water.

As originally projected, the dike was to start from near low-water line and run out into the sea a distance of 2,500 feet, and was to rise to 2 feet above mean low water. The beach on the line of the jetty from high-water level was to be protected by sinking gabions in the beach with sand heaped over them and by covering the surface with a layer of mattresses and stone.

The stone for the jetty was to be deposited in place from barges, and cribs were to be used if practicable. It was found, however, that cribs could not be used, on account of the strong currents and high seas, and that the ocean swell, even in quiet weather, was too great to permit the use of stone barges. Accordingly, the jetty had to be built from the shore end by carrying the stone out over a tramway, and was begun at high-tide line instead of at low-tide line, thus making the total projected length of the jetty in 1881 3,700 feet.

In 1884 the jetty was extended shoreward a distance of 316 feet, to close a gap that had been washed out by the sea, making the total projected length at that time about 4,000 feet.

The present project, adopted in 1888, is to raise the south jetty to full high water without extending it seaward, thus making its total length 3,748 feet, and to construct a mid-tide jetty on the north side of the entrance, about 2,300 feet in length, extending from the north head along and behind the reef, putting out from the head to a point opposite the end of the south jetty, and distant from it about 1,000 feet.

The project of 1888 was modified in 1892 by the requirement that the north jetty be raised to full high tide, and that five groins be built from the south jetty channelwards in order to prevent the currents undermining the jetty.

APPROPRIATIONS.

Act of—	
June 14, 1880	$40,000
March 3, 1881	10,000
August 2, 1882	60,000
July 5, 1884	50,000
August 5, 1886	75,000
August 11, 1888	150,000
September 19, 1890	165,000
July 13, 1892	85,000
Total	635,000

Amount expended to June 30, 1893.—The amount expended on the project to June 30, 1893, was $600,849.84.

Results obtained to June 30, 1893.—The north jetty had been built to its full length, but was not finally completed. The south jetty tramway had been repaired and the groins authorized had been partially completed.

As stated in my report last year, while the condition of the entrance had been very satisfactory, a new complication had arisen in the shape of an inner bar about 2,000 feet inside the ends of the jetties. During the winter of 1892-'93 this inner bar shoaled to a depth of 7 to 8 feet at low water, and the steamer *Willamette Valley* touched upon it several times when going in or out at a high-water stage. It caused a great deal of apprehension, and was carefully watched. During the summer of 1893 the bar gradually disappeared.

Amount expended during fiscal year ending June 30, 1894.—The amount expended on the project during the fiscal year ending June 30, 1894, was $25,398.93.

Results obtained to June 30, 1894.—The results were practically the same as for the preceding year. A good bar depth and location of channel were kept uninterruptedly during the year.

The inner bar, which gradually disappeared during the summer and autumn of 1893, reestablished itself in its former location and proportions during the winter and spring just passed (1893-'94). This has not as yet been any actual detriment to commerce, although there are grave apprehensions that it may become so.

Report of operations.—At the beginning of the fiscal year the work of completing the south jetty and the groins extending out therefrom was in progress. This continued until the end of September, when it was deemed wise to move over to the north side, and dump as much rock as possible with the available appropriation in the gap left in the north jetty.

In all 16,332 tons of rock were dumped on the south jetty and its groins and 5,494 tons on the north jetty.

Work ceased on October 31, and all property was stored and everything laid up until more funds should become available.

During September and October a survey of the bar and the bay in the vicinity of the jetties was made.

Recommendations and remarks.—The work at Yaquina Bay, according to the project which has been adopted for its improvement, is nearly completed. The only work remaining is to add stone enough to the jetties to insure their stability. If the project is in no wise extended or modified, it is believed that the sum named for Yaquina in the pending river and harbor bill, $35,000, will be sufficient to fully complete the work.

The work of improvement has been successful in giving a good depth of 12 to 14 feet at low water on the bar at the entrance to the bay, but, as stated in my last annual report, an inner bar has formed, which threatens to become a serious detriment. This inner bar forms during the winter and spring, and gradually disappears during the summer and autumn.

It was on account of the known existence of this inner bar and a contemplation of the complications which might arise therefrom, necessitating changes in the project and increased expenditure, that in my last annual report I recommended an appropriation of $120,000, the balance of the estimated cost of the project.

The inner bar having reappeared during the past winter and spring, and the matter having been carefully studied, I, on the 30th of March last, submitted a report advocating a change in the existing project, which I believe would do away with the inner bar.

Colonel Mendell, the Division Engineer, to whom the report was submitted, indorsed it to the effect that it appeared expedient to defer for the present the work proposed, hoping that time would cure the existing defects in the channel. The correspondence on the subject is herewith:

LETTER OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., March 30, 1894.

GENERAL: I deem it my duty to invite attention to the condition of affairs at Yaquina Bay with reference to the improvement of that harbor. The work under the present project is now nearing completion; both jetties have been built to their full length, and it only remains to add sufficient stone to bring the enrockment to a condition of practically permanent stability at high-tide level.

The effect so far has been to make an effective and permanent bar channel of 12 to 14 feet depth at the mean of the lower low waters, but a new complication has arisen in the formation of an inner bar inside of the outer ends of both jetties. The first time I was made aware of this inner bar was during the winter of 1892-'93, when word came that the steamer *Willamette Valley*, drawing about 12 feet, dragged on the bottom at a nearly high-tide stage. As soon thereafter as practicable soundings were taken to determine the nature and extent of the shoaling, and these soundings have been repeated as often as practicable ever since, and the character and changes of the shoal have been studied.

During the early part of the year 1893, while active operations on the jetties were in progress, it was practicable to make soundings on this inner bar frequently and determine the changes, and it was found that, as the year wore away, this inner bar gradually disappeared, and it was hoped that this disappearance would be permanent. It has, however, been found that during the past winter this inner bar has again developed to an extent equally as bad as that of the previous winter.

There being no steam vessel plying on the bay, it has been impracticable since the cessation of work to make surveys on this inner bar as often as formerly, but recently a survey was made during a calm day with a small boat which indicates the re-formation of this bar. A plat is herewith, which shows in black the condition during 1893, and in red are given the soundings in March, 1894.

I also send herewith a plat of the lower portion of the bay from the survey of August and September, 1892, with the jetty work up to date, and on the same sheet are given the profiles of the soundings taken in the channel, and all reduced to the same datum, the plane of the lower low waters.

With the small boat it was impracticable to go farther than indicated by the full black line in March, 1894. These profiles indicate the great and rapid changes which take place in the portion of the harbor lying between the jetties, and soundings made on flood and ebb tides indicate that the inner bar is built up by the flood and scoured down by the ebb, sometimes, as much as 4 feet on a single tide.

It is also the concurrent testimony of all making use of the harbor that this inner bar is not so bad in summer as during the stormy times of winter and spring.

It is altogether probable that unless something is done to prevent it this inner bar will build up and become a serious obstruction to navigation during the winter season, possibly preventing the use of the harbor at times by vessels which could cross the outer bar.

Having outlined the existent conditions and after making a study of the problem I deem it my duty to submit my views as to the cause of the trouble and its cure.

The map herewith shows that the entrance to Yaquina Bay lies in a bight, that the general direction of the coast line is due north and south, and that the jetties open out toward the southwest. I have drawn a line through the end of the south jetty parallel with the general coast line, and this cuts the north jetty 650 feet in from its end.

Now, it is my opinion that it is to this extension of the north jetty farther beyond the coast line than the south jetty that the formation of the inner bar is due, either wholly or in great part. In support of this opinion I beg to state that—

First. Previous to the extension of the north jetty for this last 650 feet there were no indications of the inner bar. The survey of June, 1891, when the north jetty was about 700 feet short of its present length, shows a depth of 24 and 25 feet in the channel where is now situated this inner bar.

Second. During the winter season the prevailing storms are from the south and southwest, and the heavy seas caused by these storms have a direct entrance to the harbor between the jetties, enabling them to exercise a maximum effect upon any shoals met with.

Third. These southerly and southwesterly storms create northerly storm currents along the shore, and these currents are loaded with the sand stirred up by the wave action. If we imagine the tide flooding and these storm currents, sand laden, moving northerly past the end of the south jetty, meeting the projecting end of the north jetty, and being thus deflected into the harbor, we can see how the inner bar is supplied with its sand.

This action could readily be seen during the spring. A sand spit was built out from the south shore and tailed out to the north in advance of the end and beyond the line of the south jetty prolonged. This sand spit was receiving constant accretion, but was kept from any great extension northward by the currents ebbing and flooding from and into the harbor.

The remedy which suggests itself for the conditions is to extend the south jetty so that its end shall be as far from the general shore line as the north jetty, or somewhat beyond it.

If the south jetty be extended 500 feet its end would be in advance of the north jetty, and the northerly sand-laden storm currents would to a much greater extent be carried past the north jetty and not to so great an extent be deflected into the harbor. This extension would in addition be somewhat of a protection against the southerly and southwesterly swells coming into the harbor.

Such an extension would reproduce to a great extent the conditions previous to the formation of an inner bar.

Based upon the foregoing, it is my recommendation that the south jetty be extended 500 feet beyond its present end.

The estimated cost of this extension is $50,000.

The only objection which I can see to this extension of the south jetty is that it will probably throw the outer bar more toward the outlying reef, and the outer bar would be deprived somewhat of the protection coming from this reef. The extension is not sufficient, however, to drive the outer bar far enough seaward to deprive it of the protection of this reef.

I do not propose this extension of the south jetty in the full and certain conviction that it will prove a complete remedy against the formation of the inner bar, but rather as an experiment, which the chances of success, in my opinion, justify.

In this connection I beg to state that in my annual report I made an estimate of $120,000 for Yaquina Bay. In making this estimate I had in mind the existence of this inner bar and the fact that some measures would undoubtedly be necessary to do away with its obstructive character. The estimated amount of $120,000 will be amply sufficient to complete the existing jetties and to extend the south jetty 500 feet, if it can be made available while the south jetty tramway is still in a condition for use.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. G. H. Mendell, Division Engineer.)

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., April 18, 1894.

CAPTAIN: Your letter of the 30th ultimo, reporting formation of an inner bar at Yaquina Bay, Oregon, and recommending extension of the south jetty at that locality at an estimated cost of $50,000, is received.

The following copy of indorsement of the Division Engineer forwarding your letter is furnished for your information:

[First indorsement.]

U. S. ENGINEER OFFICE,
533 KEARNY STREET,
San Francisco, Cal., April 11, 1894.

Respectfully forwarded to the Chief of Engineers, U. S. A.

The jetty channel was for years maintained in good shape as to width and depth between sand banks that during this period were fixed. In 1891–'92 they began to change. The map of 1892 showed a shoaling, which has since become worse. The channel was shifted to the south, so as to threaten the south jetty. The width of waterway has been increased and the waters scattered. These changes occurred during the period of extension of the north jetty. It is natural to attribute the changes to this prominent circumstance. Yet, apart from coincidence in occurrence, no definite relation between these circumstances has been established.

The shoaling does not appear to interfere with navigation to any great extent. There is no present emergency. Perhaps all these changes may turn out to be steps in a readjustment which, when established, may give a settled channel as good as existed before. In the meantime we may get new light.

It appears to be expedient to defer for the present the question whether or not the south jetty shall be extended as recommended by Captain Symons.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

By command of Brig. Gen. Casey:

Very respectfully, your obedient servant,

H. M. ADAMS,
Major, Corps of Engineers.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

As the amount named in the pending river and harbor bill will be sufficient to complete the work as projected, and as the question of modification of the project to meet the difficulty of the inner bar has been deferred, I make no recommendation for further appropriation at the present time.

Future operations.—Property will be cared for until a new appropriation is available, and when this occurs the work of adding rock to the north and south jetties will commence.

The report of Mr. J. G. Holcombe, assistant engineer in local charge of the work, is herewith.

Money statement.

July 1, 1893, balance unexpended	$34,305.59
June 30, 1894, amount expended during fiscal year	25,398.93
July 1, 1894, balance unexpended	8,906.66
July 1, 1894, outstanding liabilities	100.00
July 1, 1894, balance available	8,806.66
Amount (estimated) required for completion of existing project	120,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

REPORT OF MR. J. G. HOLCOMBE, ASSISTANT ENGINEER.

NEWPORT, LINCOLN COUNTY, OREG., *June 10, 1894.*

SIR: I have the honor to submit the following annual report of operations on the work of improvement of Yaquina Bay, Oregon, for the year ending June 30, 1894:

Local charge.—During the entire year I have been in local charge of all operations.

Duration of work.—Active operations were carried on as follows: On the north jetty, from October 1 to November 1, 1893; on the south jetty, from July 1 to September 30, 1893; at the quarry, from July 1 to October 30, 1893; by the tug *Richardson*, engaged in towing between the quarry and jetties, July 1 to November 2, 1893. Surveys of the bar and channel between the jetties were made September 6 to October 31, 1893, and on March 21 and May 18, 1894. Care and protection of public property at Newport and the Government quarry, July 1, 1893, to June 30, 1894.

Inspections.—Official inspections were made during the fiscal year by Colonel Mendell on October 12 and 13, 1893; by Captain Symons, on September 2 and 3, 1893; by Lieutenant Shunk, on October 12 and 13, November 1 and 2, 1893, and March 17, 1894; and by the Hon. Binger Hermann, July 6, 1893.

Condition of north jetty June 30, 1893.—At the end of last year all work had been suspended on this jetty since January 10, 1893. When operations ceased on that date a low place was left in the enrockment between bents No. 67 and No. 103. As the top of the enrockment was below high tide, it was deemed advisable, before closing down the works, to build this gap up to and above high tide, thus practically bringing about the conditions of the completed project as far as the length and height of the jetties were concerned.

Operations.—The crew was transferred to the north jetty on October 1, and the dumping of rock was resumed between bents 67 and 103. At the end of October, 1893, all operations ceased for the year.

The gap was filled to the required height. During the one month there were placed on the jetty 5,494 tons of stone, making the total amount of rock expended on this jetty up to date 131,126 tons.

During the year the cost for rock on this jetty was as follows:

Labor of unloading and dumping on the jetty	$1,182.22
Supplies and fuel	155.88
Quarrying of stone	1,997.11
Towing from quarry to jetty	500.00
Total	3,835.21

This is the cost of 5,494 tons of rock in place, or $0.698 per ton. This does not include the cost nor depreciation of plant, but does include the office expenses incurred at Newport.

Sand fence.—The beach north of the jetty having filled in to a height near the top of the enrockment, it was determined to build a fence on the north side of the jetty along the beach between high and low water, using the old foot planks from the abandoned track on this jetty. These planks were spiked to the piles forming the north side of the tramway. The fence as built was about 1,000 feet long and 5 feet high. The labor was furnished by the crew of the surveying boat when the weather prevented work on the bar. Besides this, the cost of labor and stores was $84.75. The fence has answered its purpose, which was to prevent the sands filling in behind the jetty from being carried over into the channel. About 400 feet of the outer or sea end of the fence were carried away by the storms of the last winter. Back of this it is in good shape, and is being backed up with sand and drift, which will cause the remaining fence to stay in place.

Water supply.—As reported in my last annual report, the winter of 1893 froze and bursted the pipe line from the tank at the spring to the engine house on the dock. Before beginning operations in October, the entire line was repaired by the carpenter employed on the works, working at odd times when nothing of immediate importance was in hand. No cost for new material was incurred.

Accidents.—No serious accidents are reported to men, plant, or jetty during the past year; the storms of the past winter did some damage, but nothing to call for special mention.

Miscellaneous.—The miscellaneous work done on this side during the year was of a minor character, and consisted in giving the hoisting engine on the dock an overhauling and putting it in good order. On this engine, Detroit sight-feed lubricators were substituted for the old tallow cups, and new tubes were placed in the boiler where the tubes had burned out or failed from any cause. No other repairs were made to the plant of this jetty.

Condition of south jetty June 30, 1893.—At the end of last year the works were in the following stage of progress: The pile driver had completed the tramway for the five groins and had about completed rebuilding the main tramway to its final end under the present modified project, and was engaged in building the spur tracks to enlarge the stone mound at its end; the rock crew were placing rock upon the main jetties and filling in the groins, five in number.

Pile driver.—The driver completed all work called for, including the building of a beacon at the end of the jetty, and was hauled back to its turnout by July 3, and the crew laid off.

Rock crew.—During the last year, this crew were employed from July 1 to September 30 in placing rock upon the main jetty and groins, and in that time they placed 16,393 tons of rock, making the enrockment at all points above high tide.

The cost for the enrockment during the year was as follows: Labor of unloading and dumping in place, $3,728.82; supplies and fuel, $578.36; quarrying of stone, $5,890.95; towing, from quarry to jetty, $1,500; making a total of $11,698.13 for 16,393 tons of rock in the jetty, or $0.714 per ton. This does not include the cost nor depreciation of plant, but does include the office expenses incurred at Newport.

Repairs to tramway.—The tramway of this jetty is old and needed constant attention and repairs to make it safe for the rock trains. These were made over its entire length, and cost as follows: Labor, $538.73; material, $75.32; total, $614.05. This is an average of about $204.68 per month. With the exception of one place beyond groin No. 5, where the storms of the past winter spent the force of the waves, it is now in a fair condition and will not need further repairs for some little time; beyond groin No. 5 the repairing will cost about $400 to make it safe for the trains and driver.

Accidents.—No accidents to the force are reported. To the plant, the only one of note is that the mast of the derrick on the receiving wharf, while lifting a large rock, gave way on July 12, 1893. This was replaced by a new mast and the work was resumed. The storms of the past winter have left the jetty as a whole in fair condition, with the exception as noted above, beyond groin No. 5.

The angle between the jetty and groin receives the whole force of the waves and confines the damage to about 150 feet of jetty beyond the groin, where, if it were not there, the waves would race along the entire jetty and the damage would extend the entire length, as in former years.

Miscellaneous.—The miscellaneous work on this side during the past year consisted in the repairing of plant, for which work a carpenter and blacksmith were constantly employed; besides the minor repairs to cars and scows that were being constantly made, a mast for the derrick was made and erected; a new set of tubes were placed in the boiler of the hoisting engine on the receiving wharf; a new tube sheet put in the locomotive fire box; and the engine for the quarry altered and repaired before it was sent to the quarry for use on the new land derrick. In this work of making repairs, it has been the aim to do all possible work by the regular force. This has resulted in a saving of time and money, as it did not require any of the working plant to be removed, and advantage could be taken of Sundays and nights to make the repairs on plant in use.

Condition of quarry June 30, 1893.—At the end of last year the work at the quarry was in active operation and preparations were being made to erect a land derrick at the lower end of the quarry.

Rock.—During the year the quarry furnished to the jetties 91 scow loads, or 21,887 tons of rock. In getting this quantity of rock it was necessary to remove by train 9,127 cars of débris, or about one-half ton of débris to a ton of rock sent to the jetties.

The cost during the year for this part of the work was as follows: Labor of quarrying, removal of débris, and loading on scows, $6,681.50; fuel, stores, and material, $484.53; total, $7,166.03. This is the cost of 21,887 tons of rock sent to the jetties, or about $0.327 per ton loaded on scows at the quarry. This does not include the cost nor depreciation of plant, but does include the office and incidental expenses incurred at Newport.

Accidents.—No accidents to the force or plant are reported for the year. The plant is in fair condition.

Miscellaneous.—During July a new land derrick was erected at the lower end of the quarry, to replace the one wrecked by the slide of December. 1892. An engine that was stored at Newport was altered and connected to this derrick, where it gives satisfaction.

Some prospecting was done at a place about 1 mile above the present quarry to see if a better class of rock could not be found. After a small amount of work was done it proved to be of the same quality as that which the present quarry furnishes, and no further work was done at this site.

The mess house during the past year was run by Jacob Valaer, who gave satisfaction, no complaints having reached this office. The food was abundant and of excellent quality.

Towing.—The towing during the past year was done by the tugboat *T. M. Richardson*, under a monthly contract for $500 per month. The cost of this part of the work was $2,000, and during the four months that work was in progress she handled 91 scows of rock, or 21,887 tons, making the cost about $21.98 per scow load of rock, or $0.09 per ton, sent to the jetties. In addition to this she did all the incidental work of transportation required on the bay. She has given excellent service, and at no time during the year have we been out of rock at the jetties.

Scows.—The scows used last year are the property of the Government, and are eight in number, being numbered as follows: 7, 8, 9, 10, 11, 12, 13, and 14. They are in fair condition, but from constant use they need hauling out and recalking. With this done they will be good for several years. Repairs were made to the sides and rakes when necessary. There are six other scows on the works, five of them being old and unfit for work and are not used at all.

Examination for rock.—During December, 1893, under instructions, I made an examination and reported on all possible quarry sites along the Oregon Pacific Railway, the company having kindly placed a locomotive at my disposal to enable me to make a complete examination.

Survey.—During September and October, 1893, a complete survey of the bar and harbor between the jetties was made. This survey showed some changes from the survey of the previous year, but little of note beyond the fact that the channel over the bar is farther to the south. This survey has been supplemented by surveys between the jetties on March 21 and May 18. The maps of all have been sent to you.

To make the survey on the bar, the Oregon Pacific Railroad kindly placed the bar tug *Resolute* at the service of the Government, and we found it of value in enabling us to work when otherwise a small boat would not have been able to go out.

Commerce.—I append to this report, as usual, the commercial statistics of this port. In this connection I wish to call attention to the fact that they are small because of the troubles of the railroad, legal and otherwise; but lately developments have taken place in this immediate country that are destined to make very material alterations in the exports of this bay and not depending on the railroad being extended. One of them is the working of the Pioneer Stone Quarry, the proprietors of which have begun the shipment of sandstone to San Francisco and other markets. The sales of this building stone have been only limited by the ability to quarry it fast enough to meet the demand. The company are now putting in modern quarry machinery and have a steamship engaged in taking full cargoes to San Francisco.

Coal.—During the last year active work has been going on in the development of the coal lands in this section. Coal of good quality was found, and it is thought to be in paying quantity. I am told that contracts have been let for a diamond drill outfit, and a thorough examination will be made of the field. It is hoped that the day is not far off when this port will yet ship products of its own production and render the improvements already made here productive of further good to the State and General Government.

Results.—The improvements under the present project are all but completed, and the results have been very satisfactory. Before the works were commenced there were but 7 feet on the bar at low water. To-day there is 14, and there has not been a vessel bar-bound for two years. During the past winter the *Homer* came in during the hardest and roughest storm of the season, and it is a common thing for vessels calling at this port to come in at low tide. This a few years ago would not have been thought of.

Before closing this report, I wish to express my thanks to Mr. M. W. Davies, clerk and timekeeper; George Williams, foreman at the jetties, and Arthur Rochester, foreman at the quarry, for the efficient and faithful services rendered by them in carrying out the details connected with this work.

Very respectfully,

J. G. HOLCOMBE,
Assistant Engineer.

Capt. THOMAS W. SYMONS,
Corps of Engineers.

COMMERCIAL STATISTICS.

Yaquina Bay is in the collection district of Yaquina. Yaquina City is the port of entry. The nearest light-house is at Yaquina Head, 4½ miles north of the entrance.

The following returns are furnished by Mr. J. G. Holcombe, assistant engineer in local charge of work at Yaquina Bay; they are for the fiscal year ending June 30, 1894:

Arrivals and departures of vessels.

Name and rig.	Net tonnage.	Draft (loaded).	Arrivals.	Departures.
		Ft. in.		
Steamship Willamette Valley	742.69	13 0	15	16
Steamship Homer	331.04	14 0	11	11
Steamship Del Norte	279.66	12 5	3	3
Steamship Scotia	132.73	11 4	1	1
Steamship Manzanita*	450	10 6	2	2
Steamship Columbine*	424.13	12 8	3	3
Steam schooner Bandorille	96.33	8 0	6	6
Tug Robarts	24.18	7 5	32	32
Total			73	74

* Light-house tender.

Total aggregate tonnage of arrivals and departures, 39,297.95.

Steamboats running on the bay and river.

Name.	Tonnage.	Draft.	Service.
		Ft. in.	
Resolute	44.92	10 8	Oregon Pacific Railroad bar tug.
Volanta	44.24	3 6	Passenger boat, Newport to Yaquina.
T. M. Richardson	24.53	5 0	Towing rock scows, Government works.

Exports and imports.

Articles.	Quantity.
EXPORTS.	*Tons.*
Agricultural implements	17
Apples	10
Bran and feed	890
Buggies	9.6
Chittim bark	37.5
Excelsior	20.4
Eggs	1.1
Flour	1,377.8
Granite	10
General merchandise	987.2
Household goods	15
Hay	15
Hides and leather	55
Lumber (62,500 feet, B. M.)	125
Oats	4,648.4
Oysters	2.5
Old iron	15
Potatoes and roots	456.3
Salmon	179
Ship knees	20
Stave bolts	24
EXPORTS—continued.	*Tons.*
Stone	305
Wheat	6,820
Woolen goods	16.5
Wood	1,827
Total	18,274.3
IMPORTS.	
General merchandise and groceries	3,210.7
Machinery	20.5
Malt	140
Coal	105.5
Sulphur	18
Grain bags	66
Dry goods	62
Hardware	326.3
Tin plate	24
Iron (pig, rod, sheet, and pipe)	217.5
Miscellaneous	880.6
Total	5,071.1

SUMMARY.

	Tons.	Estimated value.
Total exports	18,274.3	$603,000
Total imports	5,071.1	286,500

Passengers arrived by sea during year	565
Passengers departing by sea during year	657
Horses exported by sea during year	32

One small schooner, named *Leslie*, of 4 feet draft and 9.89 gross tonnage, was built at Newport during the year.

U U 7.

IMPROVEMENT OF TILLAMOOK BAY AND BAR, OREGON.

Description of original condition.—Tillamook Bay is an indentation of the Oregon coast about 50 miles to the south of the Columbia River. It has a tidal area of about 13.5 square miles, with a mean rise and fall of the tide of 6.5 feet. The usual bar exists at the entrance to the bay.

The channel over the bar is direct and shifts in position but little in comparison with the changes in many of the Pacific coast bars. Changes in position and depth are, however, effected with great rapidity.

The bay at low tide consists of three channels running through sand and mud flats. These channels are of fair depth near the entrance, but gradually shoal up, giving depths of only 1 or 2 feet near the head of the bay. Tillamook City, the principal town of the region, is situated on a tidal slough above the head of the bay, and can only be reached by light-draft vessels at high tide. To reach Tillamook City it is necessary to use the middle channel of the bay. The only other places of any importance on the bay are situated along its north shore, and access to them is by the north channel. There is no navigable connection between the north and middle channels except very near the entrance to the bay. In consequence of this, vessels entering the bay and going to points along the north shore in order to reach Tillamook City are compelled to retrace their course nearly to the entrance and then go up the middle channel.

Plan of improvement.—The plan of improvement covered by the existing and approved project is to make a navigable pass from the north to the middle channel, so that boats can go to points along the north shore of the bay and then keep right on up to the head of the bay, and up Hoquarton Slough to Tillamook City. This involves the improvement of Junction Bar, near the head of the bay, by building a dike of piles, brush, and stone to deflect the waters from the south channel into the middle channel and the improvement of Dry Stocking Bar in Hoquarton Slough by closing one of the two channels which exist there.

The estimated cost of the work approved was $100,000.

Besides the work covered by the existing project, other work has been done with the former appropriations, aggregating $5,700.

APPROPRIATIONS.

Act of—	
August 11, 1888	$5,200
September 19, 1890	500
July 13, 1892	15,000
Total	20,700

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $5,996.18.

Results obtained to June 30, 1893.—The work under the existing project done up to June 30, 1893, consisted in the letting of a contract to build dikes at Junction and Dry Stocking bars to John E. Howard. The active operations under the contract consisted in getting out piles and brush and in building the necessary scows for carrying on the work.

Amount expended during fiscal year ending June 30, 1894.—The amount of money expended during the fiscal year ending June 30, 1894, was $10,700.72.

Results obtained to June 30, 1894.—The results accomplished to June 30, 1894, were the complete construction of the Dry Stocking Bar Dike, 900 feet in length, and the construction of 1,200 feet of the Junction Bar Dike from Dicks Point northward.

Report of operations.—The actual work of dike construction was begun by the contractor in July, 1893. The extremely inclement weather prevented an earlier commencement.

The first work done was at Dry Stocking Bar. Here an old dike had been built in former years, which consisted of a single row of piles, with planking. Most of this had been carried away, but 350 feet in length was standing, with the piles in good condition. These old piles were made use of in the construction of the new dike, which consisted of a double row of piles thoroughly tied together longitudinally and laterally and filled with brush and stone between the rows, and the whole surmounting a mattress sill of brush and stone.

This Dry Stocking Dike was completed in November, 1893.

Work on the Junction Bar Dike commenced in August, 1893, and was completed in December, 1893. Its construction was the same as the Dry Stocking Dike.

The material entering into the Dry Stocking and Junction Bar dikes and their cost is as follows:

	Unit.	Price per unit.	Dry Stocking Dike.		Junction Bar Dike.	
			Quantity.	Cost.	Quantity.	Cost.
Piles	Feet	$0.08	5,532.5	$442.60	9,974	$797.92
Lumber	Feet, B. M	.12	18,894	226.73	26,213	314.56
Bolts	Each	.16	226	36.16	405	64.80
Spikes	Pounds	.04	900	36.00	2,010	80.40
Brush	Cords	2.50	535.78	1,339.45	635.49	1,588.73
Wire	Pounds	.035	1,386	48.51	2,079	72.76
Stone	Tons	.58	2,560.28	1,484.97	3,567.07	2,068.90
Total				3,614.42		4,988.07

Mr. Howard's contract required the completion of the work by September 1, 1893, but owing to bad weather and the force and violence of the elements the time of completion was extended to December 1, 1893.

It was not, however, completed until December 20, 1893, and final settlement was made by the contractor being charged with the expenses of inspection in December.

The work was under the personal charge and supervision of Mr. Philip G. Eastwick.

Recommendations and remarks.—At its head Tillamook Bay receives the waters of four rivers—the Kilchis, Wilson, Trask, and Tillamook—besides several tidal sloughs. It is about these rivers and sloughs that is situated the rich agricultural country tributary to Tillamook Bay and from which the principal demands of commerce emanate. The chief commercial center of the region is Tillamook City, situated on Hoquarton Slough. Hoquarton Slough and the Trask and Tillamook rivers unite and form the main middle channel of the bay; farther down the Wilson comes in, and still farther the Kilchis. It is observed that the troublesome bars are formed where these rivers, sloughs, and channels unite or diverge, and the main object to be kept in view in designing the improvement of Tillamook Bay is the unification of the navigable channel through the bay by cutting off the secondary channels and uniting with this navigable channel the other rivers and sloughs in the manner best calculated to do away with the tendency to form bars. All work so far done has had this in view.

The completion of the through channel along the north shore and thence direct to Tillamook City will be a great advantage to the community, and it is recommended that funds be provided for its accomplishment at as early a date as practicable.

It is estimated that $50,000 can be profitably expended upon the project during the fiscal year ending June 30, 1896.

Future operations.—With any further appropriation the first work proposed would be the extension of the Junction Bar Dike. Work in addition to this would depend on the result produced by that already done.

Money statement.

July 1, 1893, balance unexpended	$14,703.82
June 30, 1894, amount expended during fiscal year	10,700.72
July 1, 1894, balance unexpended	4,003.10
Amount (estimated) required for completion of existing project	85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Efforts have been made to secure the commercial statistics of Tillamook Bay, but without success. If any are received at a later date they will be forwarded.

U U 8.

IMPROVEMENT OF ENTRANCE TO NEHALEM BAY, OREGON.

Description of original condition.—Nehalem Bay, at high water, is about 2 miles long by 1½ miles wide at widest part, and is connected with the ocean by a narrow channel extending in a southerly direction about 3 miles. This channel varies in width from 1,000 to 2,000 feet at high tide. A low sandy peninsula, about 2½ miles long and one-fourth mile wide, lies to the west of this channel and separates it from the ocean.

The southern end of this peninsula forms the northern shore of the entrance. Between this and main shore, which limits the entrance on the south, is a distance of 1 mile. The entrance channel shifts within these limits of 1 mile, occupying sometimes a southerly position and sometimes a northerly one, and sometimes there are two channels, separated by a sand island, bare at low water. At the time of the survey of June, 1889, a depth of 6 feet was found on the bar at the northern channel. The ordinary bar depth may be stated to be about 5 to 6 feet at low water.

Plan of improvement.—The plan of improvement recommended by Captain Young was to build two high-tide stone jetties converging until the distance apart is about 500 feet, and then, if necessary, running out to sea parallel to each other to such distance as will insure a low-water depth on the bar of at least 8 feet, the north jetty to rest on the end of the sandy peninsula and the south jetty upon the mainland, the object being to hold the channel in its southerly position.

The cost of the work, as estimated by Capt. W. Young, Corps of Engineers, was $325,927.50.

Subsequent estimates, made in May, 1891, show that the cost was underestimated by Captain Young, and that the work will cost $712,388.

APPROPRIATION.

Act of September 19, 1890, "for commencement of jetty construction".....	$10,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $415.08.

Results obtained to June 30, 1893.—No work other than the making of a survey was done and no results were obtained.

Amount expended during fiscal year ending June 30, 1894.—There was no money expended during the fiscal year ending June 30, 1894. No work was done and no results obtained.

Report of operations.—On July 22, 1892, in accordance with instructions, the money on hand pertaining to the improvement of Nehalem Bay was turned into the United States Treasury. This leaves in the Treasury, available for the work whenever started, $9,584.92.

Recommendations and remarks.—No project for the improvement of the Nahalem having been definitely and formally decided upon, and no work of construction having been authorized or commenced, I refrain from making any recommendations as to future appropriations or as to the amount that could be profitably expended upon the work during the next fiscal year.

Money statement.

July 1, 1893, balance unexpended....................................	$9,584.92
July 1, 1894, balance unexpended....................................	9,584.92

COMMERCIAL STATISTICS.

Nehalem Bay is in the collection district of Oregon. The port of entry is Astoria. The nearest light-house is at Cape Meares, 13 miles distant.

The following returns relative to the commerce of Nehalem Bay and river are furnished by Mr. Edward G. E. Wist, of Nehalem. They are for the fiscal year ending June 30, 1894.

Arrivals and departures of vessels.

The number of vessels crossing in over the bar during the year was 35; the number crossing out was 35. Of this number 23 were steamers and 12 were sailing vessels. Maximum draft of loaded vessels was 9 feet 4 inches.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
Box and other lumber (3,000,000 ft., B. M.) . tons..	6,000	$40,000	General merchandise . tons.	500	$35,000
Salmon (barrels) ....do...	10	800	Machinery and agricultural implements....tons..	40	1,000
Salmon (cases) ....do...	280	40,000	Cannery supplies....do...	150	12,000
Butter ....do...	15	6,000	Miscellaneous ....do...	10	1,000
Hides and furs ....do...	3	600	Total..................	700	49,000
Elk horns ....pairs..	200	1,000			
Dressed veal and beef. tons..	1	200			
Spars	....	500			
Total.................	6,309	89,100			

SUMMARY.

	Tons.	Estimated value.
Total exports..................	6,309	$89,100
Total imports..................	700	49,000

No vessels were built on the bay during the year. During the previous fiscal year the amount of box lumber exported from Nehalem Bay amounted to only 150,000 feet, B. M. This year the exports for box and other manufactured lumber foots up to 3,000,000 feet, B. M.

U U 9.

IMPROVEMENT OF UPPER SNAKE RIVER, IDAHO, BETWEEN HUNTINGTON BRIDGE AND SEVEN DEVILS MINING DISTRICT.

The first appropriation for this work was made in the river and harbor bill approved July 13, 1892.

Description of original condition.—The Snake River from Huntington bridge to the Seven Devils mining district flows through a deep canyon, and is a river generally swift, broken by rapids and studded with rocks, rendering navigation practically impossible. The bed and banks of the river are generally of hard basaltic rock and granite.

Plan of improvement.—The plan of improvement consists in removing obstructing rocks and reefs from a selected channel 150 feet wide and putting in ring bolts and iron posts for the convenience of loaded boats lining up over the worst rapids. The estimated cost of the work is $80,000.

APPROPRIATION.

Act of July 13, 1892..	$20,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $17,998.46.

Results obtained to June 30, 1893.—The result obtained to June 30, 1893, was the removal of a large amount of rock from the upper portion of the river next below Huntington bridge.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during fiscal year ending June 30, 1894, was $1,252.66.

Results obtained to June 30, 1894.—No work was done on the river during the fiscal year.

Report of operations.—The only operations were the care of property.

Recommendations and remarks.—A large part of the last appropriation had to be expended in procuring the requisite outfit of drill scows, boats, tools, and plant generally. With the amount of money available for actual work a good start was made toward putting the river into a passably navigable condition. The work was confined to the upper portion of the river, known generally as Whisky Rapids, which form the worst obstruction in the stretch between Huntington and the Seven Devils country.

The steamer *Norma*, which was built for running on this portion of the river, has made but one attempt at running the river, and this was in the summer of 1892, before the work of improvement commenced. This trip apparently resulted in convincing her owners that the navigation of the river in its natural condition was impracticable, for she has been tied up ever since.

There is absolutely no commerce carried on on the river, and the navigation of the river must always be difficult and dangerous, in spite of all that can be done in the way of regularizing it.

An appropriation of $25,000 can be profitably expended in carrying on the work during the year ending June 30, 1896.

Future operations.—Future operations will be to continue the work of rock removal with any money available.

Money statement.

July 1, 1893, balance unexpended	$2,001.54
June 30, 1894, amount expended during fiscal year	1,252.66
July 1, 1894, balance unexpended	748.88
Amount (estimated) required for completion of existing project	60,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

There is no commerce on this portion of the Snake River.

U U 10.

IMPROVEMENT OF UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON.

Description of original condition.—Under the above head it has been deemed proper to officially include the continuous Columbia and Snake rivers from Celilo, Oreg., at the head of The Dalles, to Asotin, Wash., situated on the Snake about 7 miles above its junction with the Clearwater.

The Upper Columbia and Snake form a continuous line of navigable river, but broken by many rapids, rendering navigation difficult and dangerous.

These rapids are in nearly every instance caused by rocky bars, with occasional bowlders, and the channels are crooked and narrow.

Before improvement the ruling depth at low water was 2 to 3 feet on many of these bars, some of which were practically impassable at low water.

The Columbia was navigable all the year round, except when closed by ice. The Snake was, however, only navigable during high water and from three to four months in the spring of the year.

Plan of improvement.—Previous to 1877 $120,000 had been appropriated for the work of improvement, and had been expended in surveys and rock removal at the principal rapids.

In 1877 Maj. J. M. Wilson made a project for the improvement of the Upper Columbia and Snake rivers, consisting of removing rock bowlders and rocky reefs and scraping gravel bars in the Columbia and Snake as far as Lewiston. The estimated cost of this work was $132,000.

The present project or plan of improvement consists in removal of bowlders, gravel bars, and rock ledges, and putting in such contraction works as may be necessary.

The estimated cost of the work has not yet been accurately determined because of the lack of full and continuous surveys, and because, from the nature of things, it can not be, as many of the obstructions which it is necessary to remove are continually recurring.

By the terms of the river and harbor act of July 13, 1892, the upper limit of work under this head was extended from Lewiston, Idaho, to Asotin, Wash., a distance of 7 miles.

APPROPRIATIONS.

Upper Columbia River, act of—	
June 10, 1873	$50,000
June 23, 1874	20,000
March 3, 1875	35,000
Total	105,000
Upper Columbia and Snake rivers, act of—	
August 14, 1876	15,000
June 18, 1878	20,000
March 3, 1879	20,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	6,000
July 5, 1884	20,000
August 5, 1886	10,000
August 11, 1888	10,000
September 19, 1890	20,000
July 13, 1892	15,000
Total	166,000
Aggregate	271,000

Amount expended to June 30, 1893.—The amount expended on the project to June 30, 1893, was $162,965.98.

Results obtained to June 30, 1893.—The results obtained to June 30, 1893, have been the effectual clearing out of all the worst obstructive rocks and reefs between Riparia and Asotin in existence before work ceased. Besides the work of rock removal, dikes were built, in accordance with the approved project, at Wild Goose Island and Log Cabin Rapids. These dikes had not been fully completed, but work was in progress at the close of the year. The portions already built had a good effect in deepening the water on the bars.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $2,743.98.

Results obtained to June 30, 1894.—As the only work done to the river was adding some stone to the Wild Goose Island Dike during July, 1893, the results obtained differed very little from those above reported for the preceding year.

Report of operations.—The work of dumping stone on the Wild Goose Island Dike continued until July 31, 1893, when the force was disbanded, and the boats and property left in charge of a watchman. During July, 9 scow loads of rock were added to the dike.

The boats and all property connected therewith were taken to Lewiston and left in charge of a watchman.

Recommendations and remarks.—The river between Riparia and Asotin is an important highway of commerce. Besides the permanent work of dike construction and regularization, there is and always will be work required on this river of a temporary character, consisting of the removal of water and ice-borne bowlders, which lodge in the shallowest portions of the channel and cause dangerous obstructions, and which, even if known and avoided, limit materially the loads that can be carried on the steamboats plying on the river. The work done on the river between Lewiston and Asotin in removing these bowlders has doubled the carrying capacity of the steamers employed.

It is recommended that an appropriation of $20,000 be made for the Upper Columbia and Snake, as this amount can be profitably expended during the fiscal year ending June 30, 1896.

Money statement.

July 1, 1893, balance unexpended	$3,189.46
June 30, 1894, amount expended during fiscal year	2,743.98
July 1, 1894, balance unexpended	445.48
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1896	20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following returns are furnished by Capt. B. R. Pegram, superintendent of water lines, Union Pacific system:

Shipping.—Following are the names of steamers operated by Union Pacific Railroad Company upon Snake River, between Riparia and Lewiston and intermediate landings, during the fiscal year ending June 30, 1894, together with their tonnage, draft, and amount of freight carried:

Name.	Net tonnage.	Draft, loaded.	Freight carried.
		Feet.	*Tons.*
Spokane	531.68	4	2,215
Almota	395.24	4.5	7,639
Total			9,854

Total freight carried, 9,854 tons; estimated value of $225,000. Total number of passengers carried, 750.

U U II.

IMPROVEMENT OF COLUMBIA RIVER BETWEEN HEAD OF ROCK ISLAND RAPIDS AND FOOT OF PRIEST RAPIDS, WASHINGTON.

Description of original condition.—The portion of the Columbia from the head of Rock Island Rapids to the foot of Priest Rapids is about 60 miles in length. The river flows generally through a deep canyon. The banks for the greater part of the way are nearly precipitous bluffs from 1,000 to 3,000 feet high, composed of columnar black basalt. The country bordering the river is rocky and sterile.

The three principal obstructions to the navigation of this portion of the river are Rock Island, Cabinet, and Priest rapids. At Rock Island Rapids the river has cut around both sides of a large island of rock. The channel, however, on each side is very much obstructed with reefs, rocks, and points sharply projecting from the shore. The result is a waterway so much restricted at all stages as to dam up the waters to such an extent that they escape over lines of very steep slope, and amidst great masses of reef, rocks, and high projecting islands. A great reef is found a short distance above the head of the island which has caused extensive deposits of gravel, nearly choking the channel at low water.

The river here has a fall of 10 feet in 3,000 feet, and 12½ feet in 8,000 feet at a stage as nearly as can be ascertained of 4 feet above low water.

At Cabinet Rapids, a mass of basaltic rock projected from the left shore nearly two-thirds across the channel of the river, deflecting the current and causing it to impinge upon the nearly vertical basaltic rocks of the right bank. Other masses of rock existed in the channel in and about the main rapids. The fall here is 10 feet in a distance of 8,000 feet.

At Priest Rapids there are seven principal rapids extending over a length of 10 miles of river.

The total fall in this distance is, at low water, 72 feet, and at high water about 63½ feet.

In all these rapids the river runs through and over hard, rough, and jagged basaltic rocks.

Plan of improvement.—The plan of improvement under which work has been carried on consists in removing obstructing rocks at Priest, Cabinet, and Rock Island rapids, and putting in at all locations where they would be convenient iron posts and ringbolts to which ascending boats could make fast their lines and then wind themselves up over the rapids by means of their steam capstans, with which all such boats would naturally be provided.

The estimated cost of the work proposed was $550,000, but subsequent study and consideration are convincing to the fact that neither this nor any other sum in reason will be sufficient to attain the object aimed at, of giving a commercially practicable navigation past these obstructions under the existing plan and project.

In addition to this a survey of the Columbia from the head of Rock Island Rapids to the international boundary line was authorized.

APPROPRIATION.

Act of September 19, 1890, $70,000, of which $10,000, or so much thereof as may be necessary, may be used in the survey of the Columbia River from the international boundary line to Rock Island Rapids.

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $61,789.08, divided as follows:

For survey of river from international boundary line to Rock Island Rapids	$10,000.00
For improvement of river at Priest, Cabinet, and Rock Island rapids	51,789.08

Results obtained to June 30, 1893.—At Priest Rapids a large amount of rock had been removed from the channel selected for improvement, without, however, benefiting navigation to any marked degree.

At Cabinet Rapids a number of projecting rocks along the right bank had been removed, and some rocky island masses near the left bank were honeycombed with drifts and drill holes, loaded with dynamite and blasted, dividing the rock into small fragments, which it is expected will be washed away by subsequent high waters.

If this is the case Cabinet Rapids will be improved to as great an extent as appears necessary in the way of rock removal.

A number of ringbolts have also been put in at various points along the river for convenience of boats lining over the rapids, if any should attempt it.

The work at Rock Island Rapids was conducted with the object in view of removing obstructions which existed to boats lining up along the right bank during the higher stages of the river, and which endangered boats in running down.

That which has been done at both Cabinet and Rock Island rapids would be of benefit to navigation if any existed.

The survey of the river from the international boundary line to the mouth of the Okanogan was completed.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $200.31, in connection with office expenses and care of property.

Results obtained to June 30, 1894.—As no work was done to the river in the way of improvement, the results obtained do not vary from those above reported.

The survey authorized by the appropriation has been completed and the results published in my last annual report.

Report of operations.—No work in connection with the improvement was done during the year.

Recommendations and remarks.—I desire to invite attention to the statements under this head in my annual report for 1891 on the "Upper Columbia from the head of Rock Island Rapids to the foot of Priest Rapids," and the "Upper Columbia and Snake," pp. 3212 and 3226, Report of Chief of Engineers, U. S. Army.

As the improvement of this river by any system of regularization to give practicable navigation appears to be chimerical, and as there is no navigation of the river, no further appropriation is suggested for the work.

Money statement.

July 1, 1893, balance unexpended	$8,210.92
June 30, 1894, amount expended during fiscal year	200.31
July 1, 1894, balance unexpended	8,010.61

COMMERCIAL STATISTICS.

There is no commerce of any kind on the portion of the Upper Columbia from the foot of Priest Rapids to the head of Rock Island Rapids. Above Rock Island Rapids steamers are running from the Great Northern Railway to the Okanogan.

The following information relative to the commerce of that portion of the Upper Columbia is furnished by the Wenatchee and Okanogan Transportation Company:

Following are the names of steamboats running between Rock Island Rapids and the mouth of the Okanogan and intermediate landings, with amount of freight carried by same during fiscal year:

Steamer *City of Ellensburg* runs from Wenatchee to Virginia City, making two round trips a week. Average amount of freight carried on round trip, 65 tons.

Steamer *Nixon* runs from Wenatchee to Virginia City, making irregular round trips. Average amount of freight carried on round trip, 400 tons.

Average number of passengers carried by each boat on the up trip, 10.

Nature of cargo on up trips, lumber and general merchandise.

Nature of cargo on down trips, hides and ore.

Total amount of freight carried during year, 5,000 tons.

Estimated value of same, $150,000.

U U 12.

IMPROVEMENT OF WILLAPA RIVER AND HARBOR, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—Willapa Harbor, formerly known as Shoalwater Bay, connects with the Pacific Ocean 28 miles to the north of the entrance to the Columbia River. The only portion of the harbor to which any consideration in the way of improvement has been given is that in the vicinity of South Bend, the principal city of the harbor, and the terminus of the railroad from the main line of the Northern Pacific at Chehalis.

South Bend is situated very near the mouth of the Willapa River. Just at the upper limits of the town the river divides into a main channel and a secondary channel, known as Mail Boat Slough. This division of the waters caused bars to form in the main channel at both the upper and lower ends of the slough. There were also several bars in the river proper between South Bend and Willapa City.

Plan of improvement.—The plan of improvement adopted consists in building a dike of piles, brush, and stone across the head of Mail Boat Slough, in order to concentrate the ebbing and flooding currents into the main channel, and thereby produce as great a scour as possible on the shoals at the head and foot of the slough. Also to dredge a channel 100 feet wide and 8 feet deep at low water through the reef, just below Willapa City, and to close Louderback Slough with a pile, brush, and stone dike, with the object of compelling the currents to scour a channel through the bar in the river at its lower end. The estimated cost of the work is $31,350.

APPROPRIATION.

Act of July 13, 1892	$18,000

The language of the appropriation is as follows: "Improving Willapa River and Harbor, Washington, $18,000, of which $8,000 may be used for closing Mail Boat Slough."

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $11,658.72, of which $6,318.73 was expended in building the Mail Boat Slough dikes and $5,339.99 in the work of excavating the shoal bar below Willapa City.

Results obtained to June 30, 1893.—The Mail Boat Slough dikes were completed and the excavation of the shoal just below Willapa City was about one-third completed.

The building of the Mail Boat Slough dikes compelled a much stronger current in the main river along the South Bend water front and a deepening of the water over the bar at the lower end of the slough.

Soundings taken when the dike was completed show a deepening of the water over this bar, already brought about by the action of the dike and a marked widening of the deep channel across it.

Amount expended during fiscal year ending June 30, 1894.—The amount of money expended during the fiscal year ending June 30, 1894, was $5,842.66.

Results obtained to June 30, 1894.—The Mail Boat Slough dikes had been completed at the close of the last fiscal year and a channel was completed through the Willapa City shoal. This channel was not completed to the full width called for by the project owing to the lack of funds.

Report of operations.—At the beginning of the fiscal year the work of removing the Willapa City shoal was in progress. This was continued until August, when work ceased, owing to lack of money. There were removed altogether 3,256.9 cubic yards, leaving 772 cubic yards yet to be removed to complete the shoal to the width and depth called for by the approved project.

This work was done by contract with Mr. D. D. Clarke. This contract required the completion of the work by July 1, 1893, but owing to bad weather and the extreme difficulty of the work he was unable to complete it on time, and the contract was extended to September 1, 1893.

Recommendations and remarks.—The amount named in the river and harbor bill which has passed the House will be ample to complete the project outlined for Willapa River and Harbor, and no further appropriation is therefore recommended.

Future operations.—With any new appropriations it will be recommended to repair the Mail Boat Slough dikes if found necessary, finish the excavation for the channel through the shoal just below Willapa City, and close Louderback Slough with a dike, leaving a gap, protected by a mattress sill, for the passage of boats, logs, etc.

Money statement.

July 1, 1893, balance unexpended	$6,341.28
June 30, 1894, amount expended during fiscal year	5,842.66
July 1, 1894, balance unexpended	498.62
Amount (estimated) required for completion of existing project	13,350.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	13,350.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Willapa Harbor is in the collection district of Puget Sound. South Bend is the subport of entry. The nearest light-house is on Toke Point, at the north side of the entrance.

The following returns relative to the commerce of Willapa Harbor and River are furnished by Deputy Collector A. J. Ferrandini, of the subport of South Bend; they are for the fiscal year ending June 30, 1894.

Arrivals and departures of vessels.—The number of vessels arriving in Willapa Harbor during the year was 342; the number departing was 342. Of this number, 280 were steamers and 62 were sail vessels. Maximum draft of loaded vessels was 20½ feet.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.	*Tons.*		IMPORTS.	*Tons.*	
Lumber, (25,000,000 feet, B. M.)	50,000	$175,000	General merchandise	3,600	180,000
Salmon, fresh	60	6,000	Coal	200	800
Salmon, barrels	8	480	Machinery and agricultural implements	150	3,000
Salmon, canned	875	92,000	Furniture and miscellaneous	100	5,000
Oysters	4,000	120,000	Total	4,050	188,800
Clams	100	2,000			
Cranberries and other fruit	Unknown	20,000			
Shingles	3,036	6,300			
Hay	800	8,000			
Spruce stave bolts	3,840	7,500			
Hemlock extract	139	13,200			
Total	62,858	450,480			

SUMMARY.

	Tons.	Estimated value.
Total exports	62,858	$450,480
Total imports	4,050	188,800

One vessel was built on the harbor during the year, the *Bonita*, a fishing sloop of 6 tons capacity.

U U 13.

IMPROVEMENT OF GRAYS HARBOR AND CHEHALIS RIVER, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—The Chehalis River is the principal tributary of Grays Harbor. From the town of Montesano to the bay the river has generally sufficient water to enable coasting vessels to reach Montesano, but there are four shoals which seriously incommode navigation. At the head of Grays Harbor the waters divide into two channels, one running down the north and the other down the south side of the bay. There is also a middle channel connecting the north and south channels. In consequence of the division of the waters shoals exist near the head of the bay, seriously incommoding and limiting navigation.

Plan of improvement.—The plan of improvement adopted is to remove the shoals from the river, so as to give a depth of 16 feet at half tide, by dredging and closing side sloughs and channels, and in the bay to build dikes of piles, brush, and stone to partially close the south channel, leaving a passageway 1,000 feet wide and about 8 feet deep, and wholly close the middle channel, with the object of compelling more of the ebbing and flooding waters to flow through the north channel and scour away the existing bars.

The estimated cost of the whole work proposed is $150,000.

APPROPRIATION.

Act of July 13, 1892	$50,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $5,672.97.

Results obtained to June 30, 1893.—Up to the close of the fiscal year the works had but fairly been started. They had not progressed far enough to produce any appreciable effect in deepening the water at the troublesome shoals.

Amount expended during the fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $43,901.94.

Results obtained to June 30, 1894.—The plat herewith shows the location of the dikes built for the improvement of Grays Harbor, as they were actually constructed. The Upper Dike from the south shore of the bay to Rennies Island was completed and the dike crossing the middle channel was partially completed. In this dike all the piles were driven, the mattress laid, and brush and stone added in sufficient quantities to bring the mass up to a low-water level, and in some places above.

Work ceased January 19, 1894, funds being exhausted.

Just before the completion of the work a survey was made, the results of which are shown on the accompanying plat.

The results of the completed work are very gratifying, as the water has deepened fully two feet over Cow Point bar, near the head of Rennies Island, and the channels across the bar below Hoquiam have been readjusted and deepened materially.

Report of operations.—As stated in my last annual report, the contract for doing the work at Grays Harbor was awarded to Mr. John E. Howard, of Killgaver, Oreg.

Mr. J. M. Clapp was appointed inspector and in local charge of the work.

Active operations began April 2, 1893, and continued until January 19, 1894.

The plat herewith shows the location of the dikes as they were actually constructed, with longitudinal sections of the dikes and channels crossed by them, together with illustrative drawings of the dikes constructed.

The total length of dike and mattress sill constructed was 10,786 feet, or over 2 miles. Mr. Clapp's report, which is herewith, gives an account of the operations more in detail and specifies the amount of material put into the work and its cost.

Recommendations and remarks.—It is believed that the sum of $5,000 will be sufficient to complete the dikes in Grays Harbor, including such repairs as may be found necessary. The balance of any appropriation that may be made will then be available for expenditure in improving the Chehalis River in accordance with the project, which calls for closing certain sloughs and secondary channels, and dredging existing bars to secure a depth of 16 feet at half tide.

It is quite probable that the closure of the sloughs and secondary channels may result in deepening the water at the shoal places, and thus reduce the amount of dredging required to secure the depth aimed at.

To carry out the project it is recommended that $50,000 be appropriated, as this sum can be advantageously expended during the next fiscal year.

Future operations.—The operations with a new appropriation will consist in completing the dike across the middle channel, and making any repairs that may be necessary on the Upper Dike, and in making a survey to determine the extent of the channel changes produced by these dikes. The small dikes in the upper river will then be built and the money remaining used for dredging.

The report of Mr. J. M. Clapp, in local charge of the work, is herewith.

Money statement.

July 1, 1893, balance unexpended	$44,327.03
June 30, 1894, amount expended during fiscal year	43,901.94
July 1, 1894, balance unexpended	425.09
Amount (estimated) required for completion of existing project	100,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. J. M. CLAPP.

PORTLAND, OREG., *January 26, 1894.*

CAPTAIN: I have the honor to make the following report of the construction of the dikes built in Grays Harbor, Washington, during the past year:

Grays Harbor is an arm of the Pacific Ocean, situated about 40 miles north of the mouth of the Columbia River and about 100 miles south of Cape Flattery, lying wholly within the State of Washington.

Its principal tributary is the Chehalis River, and at the point where this river joins the harbor obstructions to navigation occur. These are caused by the Chehalis River forking and forming two channels; the one called the "north" channel, the other called the "south" channel. These two channels are connected at a point about 3 miles downstream by a middle channel.

Two shoals present themselves, which cause the obstructions to navigation, the one called the lower shoal being in the vicinity of the junction of the middle channel with the north channel. The other, or upper shoal, being in the vicinity of the place of forking of the Chehalis River, and is commonly known as Cow Point Bar.

It was with a view of removing these shoals so that ocean-going craft drawing 16 feet of water might be able to cross them at a half stage of the tide that the works of improvement were undertaken. The average rise of the tide at these points is about 8.5 feet.

The project for the improvement as adopted was to construct two dikes of piles, brush, and stone, the one partially closing the south channel in the vicinity of Cow Point. the other wholly closing the middle channel.

In the Cow Point Dike a water passage way of 1,000 feet was to be left, having a governing depth of water over the same of about 8 feet, which depth was to be retained by the construction of a continuous mattress sill of brush fascines, woven together by annealed iron wire, and sunken and held in position by weighting it with rock.

The object of this project was to compel more of the ebbing and flooding waters to pass through the north channel, and by so doing scour away the above-mentioned shoals, which are believed to be composed of sand and other sedimentary deposits, aided, perhaps, by dredging.

The river and harbor act of July 13, 1892, contained an appropriation of $50,000 for the improvement of this harbor.

The contract for the building of the above-mentioned dikes was awarded to John E. Howard, of Killgaver, Oreg, his being the lowest of the several bids offered.

The aggregate amount of this bid was $44,086.50. The original length of dike as intended was 7,500 feet. The original length of mattress sill as intended was 1,000 feet. Total, 8,500 feet. Of this length 2,000 feet were to close the middle channel.

Acting under your instructions, I proceeded to Hoquiam, Wash., and assumed local charge of the works in this harbor as inspector March 27, 1893. Active operations began April 2, 1893, the first work being the driving of the temporary piles along the site of the mattress sill, round and about which the mattress sill was constructed, the pile-driving and mattress-making going on simultaneously.

Construction of mattress sill.—By the aid of two floats, constructed of logs and planks, one placed on either side of the row of temporary piles and directly opposite each other, the mattress sill was constructed. The length of these floats was 70 feet, and they were made up of two parts, each part 35 feet long. Brush was laid on these floats at right angles to the line of sill, the width from outside to outside being about 30 feet. This brush, which was in the shape of bundles or fascines (securely tied in three places by tarred rope), was woven together in five places by No. 12 annealed iron wire.

A second tier or layer of bundles of fascines was placed on top of this bottom layer at right angles. Like the bottom layer, it was securely woven together by No.

12 annealed iron wire, and this layer was securely fastened to the bottom or first layer.

A third layer was placed in the same manner as the first layer, transverse, and on top of the scond layer; a fourth layer, in the same manner as the second layer, on top of the third layer; and a fifth layer, placed identical and parallel with the first layer, on the top.

The mattress was made in this manner the full length of the floats (70 feet). One part of the float on either side of the row of piles at the starting end was then removed, floated out from under the constructed mattress, and brought in position in front of the part of the float still supporting the mattress, this moved part now becoming the advance part.

As these parts became loaded with the completed mattress the hindermost part of the float was advanced, and it in turn became the advance float. This method was repeated until the mattress sill was completed. It will thus be seen that the mattress sill is composed of five layers, each layer being composed of bundles of brush, each bundle about 9 inches in diameter, securely fastened together by No. 12 annealed iron wire, the whole thing being continuous.

This mattress, as advancement permitted, was sunken into position by means of bags filled with about 200 pounds of sand placed along the sides of the mattress and down the center. These bags of sand were placed long way with the line of sill touching, and each bag securely tied to the mattress with wire. Rock was then placed upon this mattress sill of brush, securely weighting it.

The temporary piles driven to aid in the construction of this sill were left in place, holding the weighted mattress for a period of about three months, after which time they were pulled out. This, I am of opinion, was most beneficial, as they held this mattress in safety until it had been partly buried by sediment and sand it must have arrested in that time.

Dikes.—The main dike is located in the vicinity of Cow Point Bar, and consists on a series of straight parts intersecting adjacent parts, and changing directiof gradually. Each part is called a tangent, and numbered consecutively Tangent No. 1, No. 2, No. 3, and No. 4. Tangent No. 1 is that part of the dike on the extreme east, its east end being connected with the shore on the south side of the river. At this point the shore is protected by a mattress of brush staked to a graded bank and covered 12 inches deep with stone. The length of this protection is about 200 feet. The west end of this tangent joins the mattress sill. The length of Tangent No. 1 is 2,581 feet. The length of shore protection is 200 feet.

This part of the dike was built in every detail according to the plan and specifications of the contract, with the following exceptions:

(1) At a distance of about 1,200 feet from the shore, along the tangent, it was observed that the piles could not be driven deeper into the bottom of the river than 8 or 9 feet, the last foot of penetration being slow and difficult. The depth of water at this point varied from 7 to 9 feet. When this was observed I suspended the work of pile-driving and reported the matter to First Lieut. Francis R. Shunk, Corps of Engineers, later receiving his approval to continue the driving if the penetration did not become less than 8 feet and the water not greater than 9 feet, with instructions to strengthen the dike at this point by the addition of brace piles.

Work was then resumed and continued according to this plan, the water gradually deepening and the penetration gradually becoming greater.

I am of opinion that this part of the tangent since constructed is now as secure and substantial as any other part of the work, the penetration being into a more solid material. The water being shallow and the dike supported by brace piles every 24 feet makes this part as strong as could be desired.

(2) The filling between the rows of piling was made wholly of brush fascines, no slab wood or edgings being available on the harbor.

Tangent No. 2 is that part of the dike adjacent to the mattress sill, its eastern end starting from the western end of this sill and running westward for a distance of 1,950 feet. The construction of this tangent was similar to that of Tangent No. 1.

Tangent No. 3 is that part of the dike adjacent to Tangent No. 2, and runs in continuation of this dike for a distance of 1,335 feet, the direction being northwesterly.

Tangent No. 4 is that part of the dike on the extreme west, its length being 1,420 feet, its direction westerly, and its western end making connection with the head of Rennie's Island.

Tangents Nos. 3 and 4 run along the mud flats at the head of Rennies Island, which location necessitated the adoption of a section different from that used in the construction of tangents Nos. 1 and 2.

This section differs in so far that the panels of vertical 2-inch by 12-inch lumber lining the dike were discontinued, and longitudinal pieces of 3-inch by 8-inch plank spiked to the inside of the rows of piles substituted.

In every other particular, save that the mattress is more shallow, the construction of these tangents is similar to that of tangents Nos. 1 and 2.

The settlement along tangents 1 and 2 has been considerable, the filling in places having been repeated four times; in others, three times before settlement appeared to have stopped.

This dike was fully completed about November 17, 1893, the workmen then being transferred to the middle channel for work on the dike-building across this channel.

Middle Channel Dike.—This dike is 2,300 feet long, and was intended to close the middle channel entirely to a height of 4 feet above mean lower low water. The depth of water it crosses being so much greater than that along the main dike at Cow Point, especial care was taken to make this dike, if possible, stronger in every particular. With this end in view the piles forming the dike were driven a distance of from 17 to 21 feet into the bottom of the river, the penetration of the piles in the Cow Point Dike being from 12 to 14 feet.

The mattress of this dike consists of five tiers of brush (woven together in the manner explained above), the mattress at Cow Point, where the water is more shallow, consisting of three tiers. This mattress was sunk by means of sand bags, as explained above, and weighted with rock. This dike is in an incomplete state, although protected in such a manner as to stand the storms of winter.

The work of completing this dike should be easy and simple, consisting of a continuation of the work as already advanced.

The work from November 17, 1893, until the time of suspension was most slow and tedious. The continued rains caused the Chehalis River and its tributaries to become much swollen, the fresh water from which allowed but small run-outs at low tide. Added to this were prevailing wind storms, which caused the river to be very rough a great part of the time.

The work of bolting the dike together and the filling in between the rows of piling with brush went along interruptedly until January 19, 1894, on which date this dike had taken such shape that it was considered to be in a condition to be safely left for the winter, its present state being about as follows:

The total length of the dike is 2,300 feet; of this length about 600 feet (300 feet at either end where the dike joins the mud flats) is fully completed, being filled with brush to the proper height and weighted with rock. One thousand feet of the remaining portion was fully filled and weighted with rock, which drove the filling below the low-water surface and necessitated a second filling, which was done and again weighted, the crest of which filling now stood at a level about 4 feet above mean lower low water.

This portion of the dike was lined with 3 by 8 inch planks running longitudinally; two such strips being spiked to the piles 8 inches apart and below the inside top wales.

The high stage of the water would not admit of this lining being carried lower.

About 400 feet of the then remaining part was filled with brush to a height of about 2 feet above mean lower low water. For a part of this length the dike is lined with one strip of 3 by 8 inch planks spiked to the piles, parallel and 8 inches below the top inside waling piece. The remainder of the dike is unlined. This filling was weighted with rock, its crest being then about level with mean lower low water.

This leaves the remaining part of the dike, about 300 feet, unfilled, the mattress only covering this part.

The average depth of water originally at this place (the unfilled gap) was about 10 feet; the thickness of the mattress is about 5 feet, thus leaving about 5 feet of water on top of the mattress at a mean lower low-water level.

The continued rough weather, causing the heavy swells to break at the dike, has caused the rock weighting this filling to fall off the filling to the mattress below the surface of the water.

The filling is now quite water-logged and heavily impregnated with sediment and sand, which destroy its buoyancy and, save a few loose bundles on top, does not float. To further insure this dike against spreading, cross-ties of 4 by 4 inch lumber, 8 feet long, were spiked with 8-inch boat spikes to the pile, the brace being transverse to the line of dike. These braces occur at 6 feet intervals.

These braces serve a secondary purpose, that of holding the brush filling from being pounded out of the dike by the action of the waves.

A bolt passes through both the outside and inside wales at intervals of 6 feet; each bolt also passing through a pile. This bolt is of best quality ordinary iron, three-quarters inch in diameter, fitted with the ordinary head and nut.

The bolting securely binds the piles in each row to the adjacent piles, which rows are securely tied by cross braces of 4 by 4 inch lumber every 6 feet.

The bolts passing through these wales also prevent heavy drift which might strike the dike from ripping off the lumber, and also helps the spikes support any drift which might lodge on top of the dike until it is carried off by the succeeding high tide.

This is the condition in which the dike closing the middle channel was left, which, in my judgment, is such that no serious, if any, damage can be done to it, except by some unnatural cause.

The following table shows the amount of material received and used in the construction of the dikes in Grays Harbor, from April 1, 1893, to January 21, 1894, with the cost of the same:

Articles.	Unit.	Quantity.	Rate per unit.	Amount.
Piling	Linear feet	77,524	$0.08	$6,201.92
Fascines	Cords	11,008	2.45	26,970.70
Rock	Tons	13,236.08	.59	7,809.27
Wire	Pounds	17,353	.029	503.29
Sand bags		5,362	.08	428.96
Half-inch chain	Pounds	563		49.90
Lumber	Feet, B. M	213,314	10.50	2,239.79
Spikes	Pounds	12,600	.03	378.00
Bolts		3,130	.18	563.40
Total				45,145.23

It is estimated that to fully complete the middle channel dike, and to repair any possible damage which may have been done during the winter, the sum of $5,000 is necessary.

The following shows the length of dike begun on Grays Harbor:

	Feet.
Tangent No. 1 of main dike (completed)	2,581
Tangent No. 1 of shore protection (completed)	200
Tangent No. 2 of main dike (completed)	1,950
Tangent No. 3 of main dike (completed)	1,335
Tangent No. 4 of main dike (completed)	1,420
Mattress sill of main dike (completed)	1,000
Middle channel dike (incomplete)	2,300
Total length of structure	10,786
Total cost of structure to January 21, 1894	$45,145.23
Estimated cost of completed structure	5,000.00
Total cost of completed structure	50,145.23

Total length of dike, 10,786 feet.

Total cost per foot of structure, $4.65.

The above is the cost of the material in place, and does not include any expenses for engineering, superintendence, or office.

In conclusion I have the honor to speak of the work and ways of the contractor. This work dragged along much longer than it should have done, the contractor being away from the work about 95 per cent of the time and leaving no one in charge who had the authority to increase or diminish the force of workmen. This being the case, the force of workmen was not increased at a time when everything was favorable for work, namely, during the summer months. This was a serious mistake on the part of the contractor, and made through mismanagement or ignorance, or both, and undoubtedly cost him many dollars. The workmen employed were nearly all of a low grade of intelligence, whose chief aim, as in such cases, was to do as little work as they possibly could, and without care as to the manner of doing it.

The chief object of the contractor appeared to be simply to unload and get rid of the material as rapidly as possible, totally regardless of care in placing it where required and in the proper place. This spirit made the duties of the inspector greater, and necessitated greater vigilance about the work.

The material furnished and the work done is in every respect first-class.

The work was finally suspended January 20, 1894.

Survey.—In September, 1893, I made a survey of the river and harbor in the vicinity of the dikes for the purpose of noting the then existing character of the bottom of the river, and for a record to use for comparison with future surveys.

The effect on the river caused by the construction of these dikes can thus be determined.

The following changes are noted in the river and harbor since April, 1893, especially at Cow Point Bar shoal.

In April, 1893, the ruling depth of water over this bar at a zero stage of the tide was 6 feet, the bottom of the river being soft. Soundings taken over this same bar in January, 1894, show the ruling depth of water to be about 8.5 feet, the bottom

then being quite hard, indicating its character as that of compact sand. Below the mouth of the Hoquiam River the channels have very decidedly changed.

At this point the north channel forks and causes two channels, one called the north channel, the other called the south channel of the north channel.

In April, 1893, the north channel was the deeper channel by about 2 feet. In September of that same year, it was found that the south channel of the north channel was 2 feet deeper than the north channel.

This is indicative of a greater volume of water passing up and down this channel than formerly. The closing of the middle channel has caused a stronger flood tide to pass up this channel, and no doubt is largely the cause of the deepening of the water at this point.

The completion of the dike at Cow Point Bar has had the effect of turning a great volume of water, hitherto passing to sea by way of the south and middle channels, into the north channel, the effect of which on Cow Point Bar has been above shown.

Behind the tangents of this dike, and at the head of Rennies Island, deposits of sand and sediment are being made.

Drift which hitherto passed down the south channel is now noticed to pass almost entirely down the north channel. It is claimed by some of the steamboat men that the time of high water is longer and that the height of high water is a foot greater than formerly. I have no way of verifying this, however, as there are no records showing the heights that have occurred at Hoquiam or Aberdeen, the two cities in the vicinity of the works.

	Feet.
Highest water observed at Hoquiam	+14.2
Lowest water observed at Hoquiam	—3.1
Difference between highest and lowest waters	17.3

A tide gauge was established at Hoquiam, Wash., the zero of which is the mean of the lower low waters, the same plane of reference as adopted by the U. S. Coast and Geodetic Survey.

The zero of this gauge was arrived at by a series of low-water readings taken for two weeks in September, 1893, the necessary corrections for time and height being applied as given for this point.

Very respectfully, your obedient servant,

J. M. CLAPP.

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Grays Harbor is in the collection district of Puget Sound. Aberdeen is a subport of entry. The nearest light-house is at Toke Point, Cape Shoalwater, 14¼ miles south of the entrance. The site for a new light-house has recently been selected on Petersons Point at south entrance to the harbor.

The following returns relative to the commerce of Grays Harbor and Chehalis River are furnished by Mr. W. B. Mack, secretary, Aberdeen Chamber of Commerce, and are for the fiscal year ending June 30, 1894.

In sending the estimate of imports no details were sent, and Mr. Mack states that no record was kept of separate items. The quantity and value of imports is probably excessive.

Arrivals and departures of vessels.—The number of vessels of all descriptions crossing in over the bar during the year was 251; the number crossing out was 255. Maximum draft of loaded vessels, 17.5 feet. Minimum draft of loaded vessels, 12 feet. Of the clearances, nearly one-half of the above number carried lumber.

Exports and imports.

Articles.	Quantity.	Value.	Remarks.
EXPORTS.			
Lumber (86,500,000 feet, B. M.) ....tons..	216,250	$865,000	Vessel shipments.
Salmon, fresh ....do...	290	16,000	Do.
Salmon, barrels ....do...	30	1,100	Do.
Salmon, canned ....do...	727	71,400	Do.
Shingles ....do...	10,620	165,200	Do.
Potatoes, fruit, and forage ....do...	250	4,500	Do.
Hides ....do...	35	2,800	Do.
Basket material and manufactured stock ......tons..	5,600	22,000	Do.
Total ....do...	233,802	1,148,000	
IMPORTS.			
General merchandise, machinery, pig iron, etc..tons.	68,300	2,073,500	

SUMMARY.

	Tons.	Estimated value.
Total exports	233,802	$1,148,000
Total imports	68,300	2,073,500

Chehalis River traffic.—The number of river and bay steamers plying on the Chehalis River and Grays Harbor during the year was 7, exclusive of tugs.

Average amount of freight carried by each boat per day was 5 tons. This does not include lumber, cordwood, live stock, etc., delivered on scows.

Estimated number of passengers carried by steamers on the river and harbor during year, 30,000.

No vessels were built since last report, but plans for a schooner are now being prepared.

New industries (reported by Mr. Mack).—One basket factory, a number of shingle mills, a tub and pail factory, a smoked-fish factory, and one sawmill have been added during the past year. Nearly all of the mills have taken advantage of the dull times and lower wages to make extensive improvements to their plant, and a general revival of business will show a large increase of lumber and shingle shipments.

The inner harbor has been greatly improved by the system of dikes recently constructed by the Government.

The steamers *Point Loma* and *Cosmopolis* make regular semimonthly trips between Grays Harbor and San Francisco, carrying freight and passengers.

The coastwise steamers *Tillamook*, *Newsboy*, and *Del Norte* also run to this harbor, bringing in general merchandise and carrying out lumber.

Only a small amount of agricultural and farm produce is at present shipped out.

U U 14.

IMPROVEMENT OF CHEHALIS RIVER, WASHINGTON.

Description of original condition.—The portion of the Chehalis River that it is possible to navigate is about 90 miles in length from Claquato to its mouth. This may well be considered in three sections:

1. From the mouth to Montesano, a distance of 15 miles, there is about 18 feet of water at high water, and coasting vessels traverse this portion of the river.

2. From Montesano to Elma, 16 miles, the river is slightly affected by the tides, and has in general sufficient water for light-draft boats. But navigation is obstructed by logs and fallen trees and in summer by a scarcity of water on the bars.

3. Above Elma the river is practically blockaded during the summer and fall by snags and a general lack of water. At this time the river is a succession of shoals and pools. On many of the shoals the depth is reported to be only from 6 to 12 inches.

Plan of improvement.—The plan of improvement contemplates removal of snags, overhanging trees, jams, drift heaps, shoals, and other obstructions to navigation which may from time to time accumulate.

The cost of the work is indefinite.

APPROPRIATIONS.

Act of—	
August 2, 1882	$3,000
July 5, 1884	2,500
August 5, 1886	2,500
August 11, 1888	2,000
September 19, 1890	3,000
Total	13,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $10,848.43.

Results obtained to June 30, 1893.—The river from Montesano to its mouth was kept open and free from troublesome snags.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during fiscal year ending June 30, 1894, was $1,654.73.

Results obtained to June 30, 1894.—During September and October, 1893, the river from its mouth to Montesano was cleared of troublesome snags.

Report of operations.—When the river reached a proper stage in the fall of 1893 arrangements were made to go over the river and remove the snags which had accumulated during the past year. The work was put in charge of Mr. John Zug, who proceeded to Hoquiam, Washington, on the 6th of September, and during the next two days made an examination of the river as far up as Montesano, and found the channel obstructed in many places by snags, stumps, and overhanging trees. Arrangements were made for the use of the steamer *Montesano* to do the work, and it was accordingly fitted up for the purpose with the necessary tools and appliances. A 10-horse power donkey engine was mounted on the forward deck to furnish the necessary power for hoisting.

The following method of removal was adopted: A heavy iron chain with links 1 inch in diameter was placed around the snag and one end passed through a ring in the other end. The snag was thus held tightly by the chain which was then attached to an iron hook at the end of a 5-inch line made fast to a bit in the bow of the steamer. The propelling power of the steamer was in most cases sufficient to loosen the snag. The bight of the line was then passed through a snatch block, which was made fast to a tree or stump on shore, and the snag thus hauled up on the bank.

Several snags by reason of their great size or inaccessibility could not be removed by the above method. It was necessary, therefore, to break them up by blasting. From 20 to 50 pounds of No. 2 giant powder was used with success in each case, the broken fragments usually floating away with the current. Several overhanging trees which obstructed the river by accumulating and holding drift were removed.

There is no navigation of the river above Montesano, so no work was done above that point. The most obstructive and dangerous snags were in a sharp bend of the river just below Montesano. These required much care and time for their removal, as they could not be found except at low tide. There were also quite a number of snags in the vicinity of the Chehalis Boom, which is about midway between Montesano and Cosmopolis. Other solitary snags were found in various places as far down as Grays Harbor City.

Low tides and fine weather favored the progress of the work, during most of the time. The actual work accomplished occupied twenty-three days, namely, from the 19th of September to the 14th of October, exclusive of Sundays. The river was left free of snags and like obstructions.

Recommendations and remarks.—The Chehalis River is a highway of commerce which is so situated that it must necessarily from time to time become obstructed by snags. To keep it open and remove dangers to navigation, it is necessary to go over it once a year and remove these obstructions. Some years these amount to but little, but if violent freshets have prevailed dangerous snags may accumulate in great numbers.

There has been no appropriation for the Chehalis River since 1890, when $3,000 was appropriated.

An appropriation of $2,000 is recommended for this work, which it is believed can be profitably expended during the fiscal year ending June 30, 1896.

Future operations.—It is expected that if money is available during the fall of 1894, to go over the river again and remove any bad snags.

Money statement.

July 1, 1893, balance unexpended	$2,151.57
June 30, 1894, amount expended during fiscal year	1,654.73
July 1, 1894, balance unexpended	496.84
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1896	2,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The commercial statistics of the Chehalis River are given in the report on "Improving Grays Harbor and Chehalis River, Washington."

U U 15.

IMPROVEMENT OF HARBOR AT OLYMPIA, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—Olympia is situated at the head of Budd Inlet. The upper end of this inlet is badly shoaled. The shoals extend from the heart of the city at Fourth street bridge for a distance of 8,750 feet to a depth of 12 feet at low water in Budd Inlet. This has necessitated the building of long wharves out to the deep water, the maintenance of which, due to the ravages of the teredo, is very expensive. The alternative of this, i. e., boats coming and going only at high tide, causes great inconvenience.

Plan of improvement.—It is proposed by the plan of improvement adopted to dredge a channel 250 feet wide and 12 feet deep at the mean of the lower low waters from the vicinity of the Fourth street bridge to deep water in Budd Inlet.

The estimated cost of the work is $275,000.

APPROPRIATION.

Act of July 13, 1892	$35,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $2,313.26.

Results obtained to June 30, 1893.—The active work of dredging was commenced June 2, 1893, and was in progress at the end of the year. No results other than the commencement of the work had been obtained.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $32,669.47.

Results obtained to June 30, 1894.—A channel 6 feet deep at low water has been dredged from Fourth street bridge to deeper water in Budd Inlet. This channel as dredged is 7,645 feet long, and generally 125 feet wide. For 1,500 feet at the upper or city end of the channel, the width was reduced to 105 feet in order to keep the amount of dredging within the limit allowed by the appropriation. The Capitol Waterway was excavated to the width of 90 feet as far as the bridge.

A plat is herewith which shows the situation at Olympia and the channel dredged. In reality the channel as dredged is 10 to 20 feet wider than as shown.

Report of operations.—The dredging operations were in progress at the beginning of the fiscal year and continued until September 15, 1893. In all 237,805.73 cubic yards were excavated from within the designated limits. The work was done with a Bowers dredge, and most of the material was deposited under and near the Long Wharf. The material from the upper end was deposited under some of the neighboring wharves behind bulkheads built by the owners for their retention.

Recommendations and remarks.—The plan for the work at Olympia calls for a channel 250 feet wide and 12 feet deep at low water from the vicinity of the Fourth street bridge to deep water in Budd Inlet. The estimated cost of the work is $275,000.

This estimate was based upon a price of 20 cents per cubic yard for dredging. As a much lower price has been obtained for doing the work already let, and as it is fair to suppose that this lower price will be maintained, it is hoped and believed that the entire work can be completed at a cost considerably less than the first estimate.

Olympia is the capital of Washington, a growing and thriving city and a distributing point by water for many points. The State is about to build a new and expensive capitol building, which will require the transportation of a large amount of material. The completion of the channel to its full width and depth in the shortest time practicable is desirable in the interest of commerce.

It is estimated that $100,000 can be profitably expended on the work during the coming fiscal year.

Future operations.—With any future appropriations the first work done should be the completion of the channel to the full width of 125 feet at the upper end and the excavation of a basin to enable boats to turn, all to the depth of 6 feet at low water.

The report of Mr. John R. Savage, assistant engineer, in personal charge of the work, is herewith.

Money statement.

July 1, 1893, balance unexpended	$32,686.74
June 30, 1894, amount expended during fiscal year	32,669.47
July 1, 1894, balance unexpended	17.27
Amount (estimated) required for completion of existing project	240,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. JOHN R. SAVAGE, ASSISTANT ENGINEER.

PORTLAND, OREG., *February 3, 1894.*

CAPTAIN: I have the honor to submit herewith the report of operations in improving Olympia Harbor, Washington, during the present fiscal year, under the appropriation of $35,000 by the river and harbor bill of July 13, 1892.

On June 22, 1893, was submitted the report of operations for the fiscal year ending June 30, 1893, in which the preliminary survey for the computation of quantities was described as also the means used in locating the channel, together with a brief description of the operations of the Bowers dredge, No. 3, during the month of June, 1893.

Geiger & Zabriskie proposed and contracted to construct a dike and do the necessary dredging at the rate of 13 cents per cubic yard measured in place. The Bowers Dredging Company in turn entered into a contract with Geiger & Zabriskie to assume their obligations and do the dredging required. In view however of the ability of the Bowers dredge to remove the excavated material to considerable distances, it was decided to relieve the contractors from the necessity of building the dike, in consideration of their placing the excavated material under the Long wharf of Olympia, which is on an average about 720 feet from the center of the dredged channel.

From the south line of Second street, in Olympia, the southern boundary of the main waterway, to the outer or north end of the dredged channel is a distance of 7,090 feet.

The work of dredging was started June 2, 1893, on the outer end of this cut, the the dredge working to the south or toward the city of Olympia. In this portion of the channel—from opposite the end of the Long wharf to the north end of the channel—the dredged material was carried on pontoons about 700 feet to the east of the channel, which made the place of deposit about on a line with the Long wharf. As soon, however, as the pipe line would reach to the Long wharf, the excavated material was deposited under and around the wharf.

As a very considerable portion of the excavated material consisted of broken shells and heavy black sand, the dump heaps were of a very solid nature and made very fine filling around the old and worn-out piles of the Long wharf.

By means of water levels from the gauges established on Percival's dock and the Long wharf, known heights or levels were designated on the survey or channel piles, and thus the dredging gauges were set.

The computation of the amount of dredging required for a channel 6 feet deep at extreme low water and 125 feet wide at the bottom, from the south line of Second street north, showed 241,221.33 cubic yards, which at 13 cents per cubic yard would cost $31,358.77. Now, $31,000 was the amount designated to be expended upon dredging, thus it will be seen that the above amount of dredging could not be done, hence it was necessary to narrow the channel. It was also desired to excavate the Capitol waterway from Second street to the Fourth street bridge, hence the bottom width of the channel was made 105 feet, instead of 125 feet, on the 1,500 feet of the channel north of the south side of Second street, the east side of the channel all along being at the east side of the main waterway.

From the south side of Second street to the north side of Fourth street, the Capitol waterway was excavated with a bottom width of 90 feet, the east side of the dredged channel being on the east line of the waterway. The total amount of dredging on the lines as described above, was 237,805.73 cubic yards.

The work of dredging was started June 2, 1893, and from that date until its completion, September 15, the work was prosecuted almost continuously, Sundays, of course, excepted. The progress of the work was often delayed by the hardness of the material, but fortunately these hard places seemed only to be in spots, outside of which no better cutting could be desired as the material was then mostly sand and mud. The sand was generally heavy and black, covered with about 2 feet of mud, and all through the sand was encountered a large quantity of broken shells. In some places where these shells were especially numerous, they seemed to become cemented and formed the hard spots spoken of above. These spots were generally from 3,000 to 5,000 feet north of the south side of Second street.

The cutter used on the end of the suction pipe was not adapted to the breaking up of such hard material and hence the hard bank could not be removed as rapidly as it should have been. In fact at one time the delay was so great that it was attempted to break up this hard material by exploding charges of dynamite, but the attempt was not successful, principally, I think, because the dynamite was not used and placed properly.

The dredge continued to work south until August 20, by that date excavating 6,550 feet of the channel, and on August 21, the excavation between Hoar's and Ellis's docks, from Third to Fourth streets, was started and the excavated material used for filling some of the neighboring wharves, for which the Bowers Dredging Company received a small amount, supposed to be about 6 cents per cubic yard, but as no close account was kept of the yardage the payments were usually so much for the job.

Upon the completion of the above portion of the Capitol waterway, the dredge was faced north and the work continued toward the place where the dredging stopped August 20.

The following shows the yardage excavated per month and the length of the channel completed:

Month.	Excavation.	Length of channel completed.
	Cubic yards.	*Feet.*
June	70,000	3,400
July	75,500	1,860
August	66,500	1,820
September 1 to 15	25,805.73	565
Total	237,805.73	7,645

In these four months the dredge worked ninety-one days and excavated 237,805.73 cubic yards, whence the average excavation per day was 2,613 cubic yards. This average really, I suppose, was about 2,700 cubic yards per day, as several days were lost by minor breakdowns and in moving around. Considerable delay also ensued by reason of the pontoons and floats going aground, which usually necessitated the stoppage of the main pump.

The amount of excavation with which the contractors are credited does not amount to more than 75 per cent of the actual amount of material removed; this extra amount being due to the fact that the cut was both wider and deeper than the contract called for. It was considered more economical to do this extra amount of work than to risk the necessity of going over the work and trimming up the shoal spots. Where the contract called for a channel 125 feet wide at the bottom, the Bowers Dredging Company left one 150 feet in width, and where 105 feet was called for, the breadth was similarly 25 feet greater, and in almost every part of the length of this dredged channel the depth is from 1 to 2 feet greater than called for.

Retaining dredged material.—In retaining some of the dredged material used for filling some of the docks and wharves in Olympia, a cheap and effective bulkhead was used which some time might be useful in retaining dredged material at this or other places. It consisted merely of a row of piles about 8 feet apart, behind which, as the fill raised, were placed the tops of young evergreen trees. The bottom width was made equal to the height intended and the brush was always kept just a little higher than the fill, the brush being weighted with the sand to keep it in place. At times it was necessary to use hay or straw to stop leaks or to make the retaining wall tighter. In this manner lots and docks were filled as much as 10 feet and the cost of this retaining levee did not exceed $2 per linear foot. The construction should last several years, in Olympia at least, where the teredo is not nearly so destructive as at other points on Puget Sound.

Completion of project.—The project for the improvement of Olympia Harbor, Washington, as designed September 19, 1891, is not exactly conformable with the present state of affairs, as since that date harbor lines have been established, but the main features of the project can be easily adjusted to the present conditions. The project calls for a channel 12 feet deep at low water to Fourth street bridge, with a bottom width of 250 feet. The project also includes a basin 1,600 feet long, 500 feet wide at its southern end, thence tapering to 250 feet, 1,600 feet distant.

From computations based upon the U. S. Coast and Geodetic Survey map of

Olympia Harbor of 1891, and from the survey for the determination of quantities made in May, 1893, I have estimated that it will be necessary to remove 840,000 cubic yards to complete the project, which with the 237,805.73 cubic yards removed under the appropriation of July 13, 1892, makes a total of 1,077,805.73 cubic yards of excavation required for the whole project, as against the estimate of 1,141,575 cubic yards of September 19, 1891.

The present channel was dredged to a depth of 6 feet at extreme low water which is the same as the U. S. Coast and Geodetic Survey datum plane of 1891, of the mean of a few selected lowest low waters. This datum plane is 3.2 feet above the zero of the U. S. Coast and Geodetic Survey tide staff of 1891, a description of which, with bench marks, is on file in this office.

To complete the project to the depth of the present channel (6 feet at extreme low water) will require the following amounts of dredging:

	Cubic yards.
In the basin	190,000
From basin to deep water	151,000
Total	341,000

Assuming the above dredging to be done, to complete the remainder to give the full depth of 12 feet at extreme low water will require the following amount of dredging:

	Cubic yards.
In Capitol waterway	12,500
In the basin	141,500
From the basin to deep water	345,000
Total	499,000
From above (project to 6 feet depth)	341,000
To complete project	840,000

Future operations.—In case of a small appropriation in the future I would recommend its expenditure in the dredging of the basin to the depth of 6 feet at extreme low water and the completion as far as possible of the project to this same depth; leaving the completion of the basin and channel to full depth to later appropriations.

The present depth of 6 feet at extreme low water is ample for the present commercial needs of Olympia, and when last seen the channel showed no signs of filling.

Very respectfully, your obedient servant,

J. R. SAVAGE.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Olympia is in the collection district of Puget Sound. The port of entry is Tacoma.

The following returns relative to the commerce of Olympia Harbor, Washington, were compiled by Mr. John R. Savage, assistant engineer, and are for the fiscal year ending June 30, 1894:

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
	Tons.			*Tons.*	
Logs (10,000,000 feet, B. M.)	25,000	$45,000	General merchandise	3,500	$175,000
Lumber (3,000,000 feet, B. M.)	6,000	30,000	Coal	1,200	5,000
Sash, doors, frames, etc	(*)	10,500	Machinery	800	10,000
Fruits, fresh	(*)	15,000	Logs (1,500,000 feet, B. M., for local mills)	3,000	6,750
Potatoes and other vegetables	(*)	25,000			
Oysters (15,000 sacks)	940	37,500	Oysters (6,250 sacks)	390	15,725
Clams (10,000 sacks)	450	9,000	Clams (1,500 boxes)	70	1,350
Mussels (2,000 sacks)	100	3,000	Salmon and other fish	150	7,500
Ice	100	1,000			
Hay	500	6,000	Total	9,110	221,325
Grain	100	3,000			
Cordwood (5,000 cords)	12,800	10,000			
Wooden water pipe	23	2,500			
Ironwork	25	2,500			
Total	46,038	200,000			

* Unknown.

Exports and imports—Continued.

SUMMARY.

	Tons.	Estimated value.
Total exports	46,038	$200,000
Total imports	9,110	221,325

Passengers arrived by water during year	15,000
Passengers departed by water during year	15,000

New industries.—The Olympia Door and Lumber Company is now building a new sawmill on the east channel of Olympia Harbor whose daily capacity will be 50,000 feet, B. M. The bulk of this output will probably be shipped by water.

U U 16.

IMPROVEMENT OF SWINOMISH SLOUGH, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—Swinomish Slough is a tidal slough connecting the waters of Saratoga Passage and Skagit Bay on the south with Padilla Bay on the north. It is an important water highway furnishing the most easterly, the shortest, and safest route for the smaller class of steamboats between the northern and southern waters of Puget Sound. It skirts the Skagit delta, the richest and most extensive agricultural region of western Washington. It is, however, shallow and crooked in some portions, and the approaches to it are across the shallow flats of Padilla Bay on the north and Skagit Bay on the south.

Swinomish Slough is the ordinary meeting place of the tides, although at times the tides run in one direction entirely through.

The ordinary rise and fall of the tides in the slough is about 8 feet. As a general thing throughout the slough there was an abundant depth of water. Opposite La Conner there was 10 to 15 feet at low water; just south of La Conner this increased to 34 feet, while at the northern entrance to the "Hole in the Wall" there was a depth of 40 feet at low water.

Where the slough widens out, and especially where the Indians have been in the habit of putting fish traps, this depth decreases so that there is not over 2 feet at low water in any practicable channel. What channel there is is very crooked.

At the northern end the slough opens out into the flats forming the southern portion of Padilla Bay, in the midst of diked land and marshes.

At the southern end of the slough there are two passages connecting the slough with the waters of Skagit Bay. These passages are separated by a rocky island called McGlinns Island.

The east passage is wide and shallow, having nowhere more than 2 feet of water at low water. The west passage between McGlinns and Fidalgo islands is at the narrowest place 220 feet wide, with an ample depth of water for all purposes.

This short and crooked passage is so situated with high, rocky bluffs on either side that one can not see through from one end to the other. On account of its character it has received and is known by the very descriptive title of the "Hole in the Wall."

This is the passage used almost exclusively by steamers.

Plan of improvement.—The plan of improvement adopted is to dredge a channel 4 feet deep and 100 feet wide from deep water in Saratoga Passage across the Skagit Flats, through the shoals of the slough proper, and across the flats of Padilla Bay to deep water, and to build pile-wattled dikes in Skagit and Padilla bays to direct the ebbing and flooding waters through the dredged channels.

The estimated cost of the work is $122,000.

APPROPRIATION.

Act of July 13, 1892 .... $25,000

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $393.98.

Results obtained to June 30, 1893.—The work of dredging and dike-building to the extent allowed by the appropriation was under contract, but had not yet been commenced.

Amount expended during the fiscal year ending June 30, 1894.—The amount expended during fiscal year ending June 30, 1894, was $23,380.57.

Results obtained to June 30, 1894.—A wattled pile dike was constructed 6,180 feet long, extending from a point 400 feet west from the entrance to the "Hole in the Wall" to a point 300 feet distant from the northwest point of Goat Island.

Also a channel was dredged 6,120 feet long, having the specified depth of 4 feet at mean lower low water, or 2 feet at extreme low water, and a bottom width of 100 feet.

This channel extends from the "Hole in the Wall" westwardly, passing just north of Goat Island.

Report of operations.—The work was done under contract with Geiger & Zabriskie, of Tacoma, Wash. The wattled pile dike, 6,180 feet long, was commenced July 24, 1893, and completed November 16, 1893. It consists of piles driven 6 feet apart, between centers, driven to or cut off at mean high water. Between and around these piles fir poles about 3 inches in size at the butt were woven, the wattling extending from the bottom to an elevation of 6 feet above mean lower low water.

The dredging was done by the Bowers Dredging Company. The material excavated was carried to the north side of the wattled dike and deposited from 100 to 150 feet therefrom, making, as far as possible, a uniform bank.

The dredging commenced September 24, 1893, and was completed January 20, 1894. The long time occupied in the work was due to the bad weather and the wrecking of the dredge in a storm. The total amount of excavation within the prescribed limit was 86,585 cubic yards.

Full details of the operations are given in the report of Mr. John R. Savage, assistant engineer, herewith.

The accompanying tracing shows the work done during the year and that which it is proposed to do with subsequent appropriations.

In June, 1894, 6 piles with whitened cross arms were driven to mark the crooked natural channel from the end of the dredged channel to Saratoga Passage.

Recommendations and remarks.—Swinomish Slough is an important highway for commerce, connecting the northern and southern portions of Puget Sound, forming the shortest and safest route between them. It passes through what is probably the most fertile and productive portion of the State of Washington. Upon it is situated the town of La Conner. Very great inconvenience is experienced by boats using the slough, due to shallow water.

It is very desirable that the slough be fully opened with the least delay practicable, and it is therefore recommended that the full amount to complete the project be appropriated, namely, $97,000. This would be diminished by any amount appropriated during the present session of Congress.

Future operations.—With future appropriations, the work which it will probably be found most advantageous to do first will be the building of an intercepting pile dike from Goat to Ika islands, and the rectification of the channel from the "Hole in the Wall" to La Conner. This will require a channel to be dredged from McGlinns Island to Gallahers Point on the main shore, and the building of a dike to retain the dredged material and to shut off the channel east of McGlinns Island.

If sufficient money is available it will also be used to complete the dike and channel hitherto constructed out to deep water in Saratoga Passage.

The report of Mr. John R. Savage, assistant engineer, in personal charge of the work, is herewith.

Money statement.

July 1, 1893, balance unexpended	$24,606.02
June 30, 1894, amount expended during fiscal year	23,380.57
July 1, 1894, balance unexpended	1,225.45
Amount (estimated) required for completion of existing project	97,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	97,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. JOHN R. SAVAGE, ASSISTANT ENGINEER.

PORTLAND, OREG., *February 16, 1894.*

CAPTAIN: I have the honor to submit herewith the report of operations in improving Swinomish Slough, Washington, during the present fiscal year under the appropriation of $25,000 by the river and harbor bill of July 13, 1892.

The original contract entered into November 28, 1892, between Capt. Thomas W. Symons and Geiger & Zabriskie, to do certain dredging and dike construction in the northern part of Swinomish Slough and in Padilla Bay, was so modified April 21, 1893, that the location of the work was changed to the southern end of the slough and the Skagit Bay Flats adjoining thereto.

In the latter part of May, 1893, a careful survey was made of the locality where the channel was likely to be located and the lines of the channel and dike in Skagit Bay, as decided upon, are shown on the map herewith. The plane of reference of the soundings shown thereon is that of the U. S. Coast and Geodetic Survey, viz, the mean of a few selected lowest low waters, which is practically extreme low water.

The mean of the lower low waters was found to be 2.2 feet above this datum used and it was decided to make the depth of the dredged channel 2 feet below the U. S. Coast and Geodetic Survey datum used, which depth was assumed to be 4 feet below mean lower low water, the odd two-tenths of a foot being disregarded.

The dike.—The dike as laid down extends in a straight line from a point about 400 feet west of the entrance to the "Hole in the Wall," to a point about 300 feet distant from the northwesternmost point of Goat Island. The dike is built of piles, 6 feet apart between centers, between and around which are woven poles or brush.

The tops of the piles are driven to mean high water as determined by the U. S. Coast and Geodetic Survey to be 12.5 feet above their datum, and no part of the pile above this mean high water is paid for. When the plan and specifications were gotten up for this work, there were no data in this office regarding the tides in Skagit Bay or thereabouts, and mean high water was assumed to be 8 feet above mean lower low water, this from tidal observations taken in the slough. But as stated above, the tops of the piles were driven to 10.3 feet above mean lower low water, or 12.5 feet above extreme low water, or to mean high water, as all along intended.

The wattling, however, was carried to the height as specified in the contract, viz, to 6 feet above mean lower low water.

Quantities, progress, etc.—From the survey made in May, 1893, the estimate of quantities for the dike 6,000 feet long as laid down was 25,000 linear feet of piling, and 41,425 square feet of wattling.

Upon the completion of the dike the actual quantities for which the contractors were paid were 30,670.3 linear feet of piling and 45,056.2 square feet of wattling.

During the survey in May, 1893, the line of dike had been marked by a few stakes driven by hand, and everything being in readiness, the work on the dike was started July 24, 1893, by driving piles. The start was made about in the middle of the dike and piles driven thence west to the end, and upon the completion of that portion the driving was resumed at the extreme eastern end of the dike and work continued till the gap was closed.

The reason for this procedure was to permit the steamers to use the channel as long as possible. The east end of the dike was not connected with the shore of Fidalgo Island, a small space being left for the passage of small boats and canoes.

The piles were measured just previous to driving, and any projection of the pile above mean high water was subsequently determined and the amount deducted from the summation of the measured lengths. The piles were a rather uneven lot as regards size, and some 30 or 40 were thrown out for nonconformity to specifications. In all 1,031 piles were driven in the dike proper, but 5 more were also driven in November to form a dolphin.

In July, 1893, 340 piles were driven and by August 20 the work of driving the remaining 691 piles was completed. The piles were furnished by the original contractors, Geiger & Zabriskie, but driven by King & Marrinan, of Seattle, to whom was also sublet the work of wattling, and by them in turn sublet to McKinnon & Kerr, also of Seattle.

Wattling.—The work of wattling was started August 12, 1893, having been delayed somewhat by the nonarrival of the brush or poles. This work was started at the east end of the dike, the idea being to deflect as much as possible of the current to utilize it in scouring out the channel to be dredged. The crews at work on the wattling were all new to it, foremen and all, and several methods of putting the poles in place were tried, but the neatest and most effective work was done by placing the butts of the poles at the back of the dike and all pointing in one direction, in this case east. The poles were put in in courses, quite a long stretch of the dike being wattled at a time. The poles were wired at their joints in accordance with the specifications, and also weighted with stone. In this way about 39 coils of No. 12 annealed iron wire were used, the weight of which aggregated about 2,500 pounds.

The first lot of poles received was nearly all of large size, 3 and 4 inches at the butt, but it was found almost impossible to weave such sizes in between piles 6 feet from center to center, especially if the piles were at all large in size. Consequently all future lots of brush were from 2 to 3 inches in diameter, which smaller sizes were found to work fairly well.

The sub-subcontractors soon wearied of the wattling and left the job on the hands of King & Marrinan, who thenceforth prosecuted the work with a crew of six men—all they could very well handle on account of the delays experienced in receiving the poles. The work of furnishing these poles was also farmed out by Geiger & Zabriskie to several parties, very few of whom carried out their agreements with any sort of satisfaction or promptitude.

The work of wattling dragged along with considerable lost time on account of receiving brush, etc., till November 16, when the dike was completed.

The wattling on the easternmost 2,000 feet of the dike was originally driven down to the bottom, but the velocity of the current in this vicinity scoured out the sand from under the brush, and in some places left the wattling 3 and 4 feet from the bottom. A large portion of the sand thus scoured, however, has been deposited in the form of bank in behind the dike, which it materially aids in the deflection of the currents.

The crew doing the wattling lived on board a pile-driver, and the weight of the hammer was sometimes used to force the wattling down to the bottom.

In placing the poles for the wattling, the contractors constructed floats of logs from which the poles were woven into place. One thousand poles was the greatest number put in place in any one day, but 500 may be considered as a very good day's work on account of the tidal conditions, winds, etc., which are frequently unfavorable, causing delays. The wiring was usually done on the long runouts, previous, of course, to driving down, and the weighting with stone at almost any time. The stones of the required size, 50 pounds or over, were easily obtained on any of the rocky beaches near by. McKinnon & Kerr paid their men working on the wattling $2 per day, and King & Marrinan averaged $2.50, having a much better gang of men.

Using round numbers the area of the wattling was 45,000 square feet, to construct

Drawn by A. Downing

which 24,000 poles from 2 to 3 inches at the butt were used, and also 2,500 pounds of No. 12 annealed iron wire. From which we derive the following quantities (disregarding stone) in each 100 square feet of wattling: 53⅛ poles, 20 feet long, 2 to 3 inches butt; 5⅗ pounds No. 12 annealed iron wire. The average length of piles was about 30 feet.

Recommendations as to dike.—The plan of subletting the contract and each portion thereof, while it was profitable to the contractor, resulted in great delay and inconvenience to the progress of the work, and besides by such a system the work is liable to be not nearly so well done, as the parties doing the work received so small an amount therefor that naturally their tendency was to slight the work as much as possible. If in the construction of further wattled dikes it would be possible to make sure that only one party should drive the piles, furnish and place the brush, and otherwise complete the dike, I am satisfied that the progress would be much more rapid, and that, as a whole, the work would be much more satisfactory.

Owing to the very great difficulty experienced in weaving the brush in between the piles, I would suggest that in the future the piles be placed with 7 or 8 feet centers, instead of 6, as here used, so that a larger-sized brush, say 3 to 4 inches at the butt, could be used, and the work thus be completed at less cost and with considerably more dispatch and strength. Of course the brush would then have to be 23 or 26 feet in length, but that would make little or no difference in the cost, and by the use of larger brush the dike would be stronger and better able to withstand the floating logs, some of very large size, that abound in these waters, especially during periods of high water by river or tide. During the high tides—December 20 to 26, 1893—Skagit Bay would sometimes be almost black with these floating logs en route from the mouth of the Skagit and Stillaguamish rivers to Deception Pass, passing between Goat and Ika islands, and bearing directly for the dike. Many passed over the dike, but some would lodge and hang around for a day or two, doing considerable damage to the wattling.

I would also suggest that the size of the piles be limited to from 12 to 15 inches at the butt (inside the bark). Piles of this size will be plenty large enough, as there is, practically speaking, no pressure on the piles, and it has been found that piles of more than 15 inches diameter cause great difficulty in weaving the poles in place.

DREDGING.

Survey preliminary to dredging.—The survey for the determination of the quantity of dredging to be done was made with the wattled pile dike, whose location was known, as a base. A line of piles, 200 feet apart, parallel to the dike and 275 feet distant therefrom, was driven by the Bowers Dredging Company, for use as "swinging piles." It was at first attempted to take the soundings by running a line of soundings at right angles to the dike with a boat, getting the required distance from the dike by means of a graduated wire, but owing to the swiftness of the currents it was found impossible to do this, as the boat could not be kept on line. The floats formerly used at Olympia were then brought into use, one being extended along the dike and the other being made fast between the two swinging piles opposite. Then, by means of a graduated wire from float to float, which could be moved along from place to place, the points where soundings were desired were accurately located, and it was an easy matter for a boat to go along and ascertain the depths. In this way the section of the channel opposite the floats was soon sounded, whereupon the floats were moved up another 200 feet. The lines of soundings were usually 20 feet apart and the soundings taken at every 10 feet on these lines and referred to the Goat Island gauge, by means of which the soundings were reduced to the U. S. Coast and Geodetic Survey datum of the mean of a few selected lowest low waters.

We started sounding on September 21, 1893, and finished on the 28th, covering a distance of 6,200 feet in six and one-half days, although delayed considerably by the flats going bare.

In all, 318 lines of soundings were run and 4,770 soundings taken; these soundings, referenced to the dike, are plotted on a scale of 60 feet to 1 inch. Each line of soundings or each cross section was plotted on cross-section paper for computation, and is herewith.

From the survey of May, 1893, the required amount of dredging to the end of the dike as now constructed was 91,691 cubic yards, and from the more accurate survey just described, the amount was 86,385 cubic yards. In the May estimate particular care was taken to make the amount sufficiently large.

Dredging.—The Bowers dredge No. 3 arrived at Goat Island, September 19, 1893, and got in place the following day at the eastern end of the dredged channel, near the entrance to the "Hole in the Wall," but did not begin to work until September 25, as there was considerable work to be done previously in getting things in shape to run. Previously to starting, I had given levels on the swinging piles by which to set the dredging gauges—this by means of water levels from the Goat Island gauge.

For description of the method of procedure of the dredge, would refer to my report on Olympia, dated June 23, 1893.

Starting in September 25, 1893, the dredge worked almost continuously to the end of the month, and also three days in October, in which time 2,400 feet of the channel was dredged, the excavated material being deposited about 100 feet north of the dike; during this time the contractors received credit for removing 19,000 cubic yards of material. During the early part of October, up to the 6th, the dredge lost three days on account of the windy southeast weather, and on the night of the 6th there was a regular gale from the southeast, in consequence of which the dredge was considerably damaged, the spud frame being torn off, the cutter shaft broken, and considerable other damage done to the suction pipe. Besides this, several pontoons were smashed up and a floating blacksmith shop destroyed. The dredge crew at once started in to gather up the débris and to prepare to leave for Tacoma, where the dredge was to be repaired, but it was the 14th of October before they could get away.

The damage financially was not such a serious feature as was the delay caused by this breakdown, and notwithstanding the fact that the repairs were pushed as fast as possible, it was the 29th day of November ere the dredge got back to Goat Island, during which time several spells of very fine weather were unavoidably missed, and December 1 the dredge once again got to work.

This accident cost the Bowers Dredging Company about $5,000, not to mention the delay. The accident was undoubtedly due to trying to hold the dredge broadside to the storm with solid connections like spuds and cutter, in consequence of which both were broken. Subsequently to this accident, in case of a blow the dredge made fast to the swinging piles and raised both cutter and spuds, and in such fashion she rode out several severe blows in safety.

On December 1 the work was resumed where the accident took place, viz, 2,400 feet from the eastern end of the dike, and the dredging continued westward till the 13th of December (with loss of four days), when in consequence of the stormy weather the dredge was moved to the west end of the cut, and work started eastward on December 16, but on the 21st of December, as the weather was good, the dredge was taken back to its eastern position and started working westward again. While working east about 1,000 feet of the channel was completed. From December 21, 1893, till January 11, 1894, the dredge worked west, and on the latter date completed the main cut, but, on account of a severe and long-continued southeast gale, was obliged to wait until January 20, 1894, before completing the dredging, some little trimming being required.

The following table shows the rates of progress during the months the dredge was working:

Month.	Working days.	Excavation.	Length of channel dredged.
		Cubic yds.	*Feet.*
September, 1893	6	9,000	1,450
October, 1893	3	10,000	830
December, 1893	23	48,000	2,740
January, 1894	11	19,585	1,100
Total	43	86,585	6,120

From the above we get an average daily excavation of 2,013.6 cubic yards, or, in round numbers, 2,000 cubic yards per day. The divisor—the number of days—includes merely those days on which the dredge worked.

The material excavated was at nearly all times very easy of removal, consisting mostly of sand brought down from the rivers near by. In one or two places the sand was extra compact and sometimes mixed with a little clay, which made the removal slightly more difficult, but not enough so to cause any material delay. The excavated material was deposited to the north of the dike, usually from 100 to 150 feet distant therefrom, and it was deposited so as to make as far as possible a uniform fill. Toward the western portion of the dredged channel the excavated material was deposited very close to the dike, the depth of water and the general direction of the currents permitting this to be done.

Currents.—The currents in the portion of Skagit Bay where this work was done are very uncertain quantities, as their actions and directions are governed very largely by local conditions. Owing, however, to the influence of the North Fork of the Skagit River, the current usually runs out along the dike for about two-thirds of the time. At high water the direction of the current is usually about at right angles to the direction of the dike—in particular that portion near Goat Island.

Condition at completion.—Similarly to the dredging done in Olympia, the channel when completed by the Bowers Dredging Company was at least 125 feet wide at the bottom, instead of 100 feet as called for by the contract, and was on an average at least 1 foot deeper than required. In this way the dredger received credit for only about 75 per cent of the excavation actually done.

The dredged channel is parallel to the wattled dike, from which the center of the channel is distant 125 feet. Its specified depth is 4 feet at mean lower low water or 2 feet at extreme low water, and with a bottom width of 100 feet. The length of the channel dredged is 6,120 feet.

There is very little doubt, I think, but that the dredged channel will stay open, as the velocity and direction of the low-water currents will render filling well nigh impossible.

Completion of project.—The project for improving Swinomish Slough, Washington, calls for a channel 100 feet wide at the bottom and 4 feet deep at mean lower low water from deep water in Saratoga Passage through Skagit Bay, Swinomish Slough, and across the flats of Padilla Bay to deep water in the same, with dikes at certain parts to insure the permanence of the channel dredged or to retain the excavated material.

Under the appropriation contained in the river and harbor bill of July 13, 1892, the project has been completed to the extent of dredging the channel and building a wattled-pile dike from the entrance to the "Hole in the Wall" to the northwest end of Goat Island—a distance of about 6,200 feet.

I have computed that to complete the project the following amounts of dredging and diking will be required:

Dredging:	Cubic yards.	
Skagit Bay	42,000	
Swinomish Slough	133,000	
Padilla Bay	90,000	
Total	265,000, at 20 cents,	$53,000
Wattled and brush retaining dike:	Feet.	
Skagit Bay	7,270	
Swinomish Slough	5,330	
Padilla Bay	6,000	
Total	18,600, at $1,	18,600
Pile brush and stone dike:		
Swinomish Slough	1,000, at $6,	6,000
Total		77,600
Add 10 per cent for contingencies, etc		7,760
Total		85,360

In making the original estimate an allowance of 18,000 cubic yards at 30 cents per yard was made, the advance in price being made to cover the cost of removal of the excavated material, but in the above estimate I have disregarded such an allowance, as I am satisfied that 20 cents per yard should be ample for the work as a whole, for no more desirable dredging could be asked for, as the material to be removed is either sand or mud. I am satisfied no hard material will be encountered.

Future operations.—With the next appropriation that becomes available I would recommend the completion of the project as far as La Conner if possible, and upon the completion of that I would suggest that the work of dredging be then continued north through the slough as far as the funds available will permit.

The dike between Goat and Ika islands should, I think, be built first of all, as it is essential that the present dredged channel between the "Hole in the Wall" and Goat Island should have some protection from the southeast storms that sweep in almost perpendicularly to the line of the dredged channel.

Upon the completion of the dredging in January, 1894, there was a good natural channel leading from the end of the wattled dike to deep water in Saratoga Passage, in which the depth of water was within a foot or two of the dredged depth. In case the next appropriation by Congress for this work should not be sufficient to complete the project as far as La Conner, and in case the above natural channel retains its depth, most good will be done by improving the portion of the slough between the "Hole in the Wall" and Gallahers Point, subsequently, of course, to the construction of the dike between Goat and Ika islands. It will be sufficient, I think, to build this dike merely of a row of piles about 4 feet between centers and extending up to extreme high water, so as to catch all the drift from the Skagit and Stillaguamish rivers and to cause the lodgment of the same. Such a row of piles will very materially break the force of the currents and seas, and I think it is safe to say that in time a vast amount of drift will accumulate, which will practically make a connecting link between the two islands.

The original project has been slightly modified by the proposed use of a dike between McGlinns Island and Gallahers Point, with a channel to be dredged following the line of the dike and 50 or 75 feet distant therefrom.

For about 500 feet from either end of this dike it will be necessary to build a brush and stone dike similar to those used at Willapa and Grays harbors, but in the intermediate 1,100 feet I think a wattled dike to extreme high water will answer equally well. With this dike built to extreme high water, a large amount of drift would be collected, which would reinforce the dike and its action.

To complete the project as far as La Conner will require:

Dredging, Skagit Bay and Swinomish Slough, 68, 200 cubic yards, at 20 cents	$13, 640
Diking, Skagit Bay and Swinomish Slough, 8,370 feet, at $1	8, 370
Brush and stone dike, Swinomish Slough, 1, 000 feet at $6	6, 000
Total	28, 010
Add 10 per cent for contingencies, etc	2, 801
Total	30, 811

Or to complete the dike between Goat and Ika islands, and the diking and dredging between McGlinns Island and Gallahers Point, will require:

Dredging, Swinomish Slough, 26, 200 cubic yards, at 20 cents	$5, 240
Diking, Swinomish Slough and Skagit Bay, 5, 200 feet, at $1	5, 200
Brush and stone dike, Swinomish Slough, 1, 000 feet, at $6	6, 000
Total	16, 440
Add 10 per cent for contingencies, etc	1, 644
Total	18, 084

Very respectfully,
J. R. SAVAGE.

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Swinomish Slough is in the collection district of Puget Sound. The nearest port of entry is Port Townsend.

The following information relative to the commerce of Swinomish Slough, Washington, is for the fiscal year ending June 30, 1894, and was furnished by Mr. R. O. Welts, of La Conner:

Shipping.—There is 1 daily passenger steamer and 1 triweekly steamer running between La Conner and Seattle.

During the fall, when the hay and grain are shipped, there is a large fleet of steamers and scows running between various points in Swinomish Slough and the commercial and lumber centers on the Sound. Of these no record is kept.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.	*Tons.*		IMPORTS.		
Hops	200	$60, 000		*Tons.*	
Fruit	100	30, 000	General merchandise	5, 500	$400, 000
Oats	35, 000	700, 000	Machinery		125, 000
Hay	23, 000	207, 000	Live stock (new breeds)		50, 000
Live stock, pork, and meat		40, 000			
Salmon, in bulk	250	25, 000	Total	5, 500	575, 000
Total	58, 550	1, 062, 000			

Large quantities of lumber, potatoes, butter, hides, and vegetables shipped. No record kept.

SUMMARY.

	Tons.	Value.
Total exports	58, 550	$1, 062, 000
Total imports	5, 500	575, 000

U U 17.

IMPROVEMENT OF PUGET SOUND AND ITS TRIBUTARY WATERS, WASHINGTON.

The old title of this appropriation was "improvement of Skagit, Stillaguamish, Nooksack, Snohomish, and Snoqualmie rivers, Washington."

Under date of August 4, 1892, the change to the new title was approved and all money and property on hand were transferred and thereafter accounted for under the new title.

Description of original condition.—In their original condition the navigable streams flowing into Puget Sound carried water enough for the purpose of steamer navigation, but were obstructed by snags, fallen trees, and log jams. They were the great highways of the country, traveling on land being almost impossible on account of the heavy timber, dense underbrush, and fallen logs.

About their mouths there are, in every instance, large areas of shallow water with tortuous channels, and these are often obstructed by drift.

Plan of improvement.—The plan of improvement contemplates the removal of snags, logs, trees, and other obstructions to navigation. For this purpose a snag boat with an outfit of tools and appliances has been provided. This boat passes from one river to another, doing service in each as far as the necessities of its commerce require and as the amount of the funds appropriated will admit.

With the funds that have been appropriated this snag boat and outfit have been provided and a large number of snags, jams, overhanging trees and other obstructions to navigation removed. These, with the trees that from time to time fall into the rivers, will furnish constant employment for the snag boat for an indefinite period.

APPROPRIATIONS.

Act of—	
June 14, 1880	$2,500
August 2, 1882	20,000
July 5, 1884	10,000
August 5, 1886	10,000
August 11, 1888	15,000
September 19, 1890	12,000
July 13, 1892	15,000
Total	84,500

Amount expended to June 30, 1893.—The amount expended to June 30, 1893, was $75,493.86.

Results obtained to June 30, 1893.—In this class of work no permanent results are aimed at or obtained. The continually recurring snags and fallen trees, etc., require to be constantly removed. The rivers have been kept open for traffic, and many of the perils of navigation have been removed.

Amount expended during fiscal year ending June 30, 1894.—The amount expended during the fiscal year ending June 30, 1894, was $6,554.32.

Results obtained to June 30, 1894.—As shown more in detail in Captain Jefferson's report, a large amount of work was done in the principal rivers tributary to Puget Sound in removing snags and leaning trees, and navigation thereby was greatly benefited.

Report of operations.—The snag boat was fitted out in August, 1893, upon the subsidence of the summer floods and continued at work until December 11, 1893, when she was laid up in the Duwamish River. During this period operations were carried on in the Duwamish, Snohomish, Stillaguamish, Skagit, and Nooksack rivers, and in Sullivan

Slough. A total of 1,313 snags, 63 leaning trees, and two steamboat wrecks were removed.

Capt. E. H. Jefferson has continued in charge of the snag boat. Besides his work in connection with snagging, Captain Jefferson has rendered valuable assistance to this office in many questions which have arisen concerning bridging and obstructing the waters of Puget Sound and its tributaries.

His report, which is herewith, gives full data as to the operations of the snag boat.

In November, 1893, Captain Jefferson had occasion to discharge three deck hands for misconduct of various sorts. These men went before the United States district attorney and the grand jury at Seattle and made complaint against him for violation of the eight-hour law. The grand jury found a true bill against Captain Jefferson and issued an order for his arrest about December 28. He was tried before Judge Hanford by a jury during January, 1894, and acquitted, the jury recognizing the propriety of the decision of the War Department that the law is not applicable to the crews of steamboats, snag boats, etc.

Recommendations and remarks.—The work of the snag boat *Skagit* is of great importance in keeping the rivers tributary to Puget Sound in a navigable condition so that steamers, scows, lighters, etc., can ascend and descend, and that logs, lumber, wood, etc., can be floated down.

The *Skagit* was built in 1882, and has had very hard usage ever since, and the time has now come when it is absolutely necessary to rebuild her. Her hull is rotten and weak and so water-logged that she draws too much water for use on the rivers during the periods in which she can be used to the best advantage. She is so water-logged and down by the stern that it is almost impossible to steer her.

She is now 12 years old, which is more than the average life of Puget Sound fir when exposed to air and water.

The boat in going from river to river has to traverse the open waters of Puget Sound, and this in her present weak condition is dangerous. The machinery of the boat is good. Experience also demonstrates that certain changes and additions are needed to make the snag boat what it should be. For instance, she should be provided with a strong "spud" or "grouser" to hold her in place in a swift current, and she should have a force pump to enable the sand to be washed away from snags so that they can be taken hold of.

To rebuild the boat and make the requisite additions will cost, it is estimated, $12,000. It is recommended that this amount be appropriated in addition to the amount required to operate the boat, $20,000, making $32,000 in all.

Future operations.—With the balance of the appropriation remaining the boat will be put at work as soon as the summer floods are over and kept at it while the waters of the rivers remain in proper condition therefor.

The report of Capt. E. H. Jefferson, master of the Government snag boat *Skagit*, is herewith.

Money statement.

July 1, 1893, balance unexpended	$9,006.14
June 30, 1894, amount expended during fiscal year	6,554.32
July 1, 1894, balance unexpended	2,451.82
July 1, 1894, outstanding liabilities	50.00
July 1, 1894, balance available	2,401.82

Amount (estimated) required for completion of existing project....... Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1896 $32,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF CAPT. E. H. JEFFERSON, MASTER OF SNAG BOAT.

SEATTLE, WASH., *May 10, 1894.*

SIR: I have the honor to submit the following annual report of operations of the United States snag boat *Skagit* at improvement of Puget Sound, Washington; also some commercial statistics of the various rivers in this district.

On August 10, 1893, after the passing of the regular summer floods, commenced getting the boat ready for service at her moorings in the Duwamish River. On the 12th the boat was taken down the river to Seattle, where some minor repairs were made and supplies taken on board.

August 17, everything being in readiness for work, departure was taken for the Snohomish River and operations commenced there the same day and continued between mouth of river and city of Snohomish, removing snags that had been deposited by recent floods till the 22d, on which date left the Snohomish River for the Skagit, via the Stillaguamish, working near the mouth of the latter till the evening of the 28th; then ran over to the Skagit.

Worked on the Skagit between its mouth and Mount Vernon till noon of September 6. The river then being a little too high and the water too much discolored for further effective work, left on the last-named date for the Nooksack River, arriving and commencing work on the 7th. Operations were conducted on this stream till and including October 5 and the river pretty thoroughly cleaned of obstructions as far up as Lynden, the head of navigation, during which time the stage of water was at times so low that the boat could scarcely float in places, and had to be hauled over with the aid of lines and the steam capstans.

October 6, left the Nooksack River and returned to the Skagit, where work was continued till the 30th, on which date ran over to Sullivan Slough and removed the wrecks of two burned steamboats, which were, in their wrecked and sunken condition, a serious obstruction to the navigation of the slough by steamers and barges which had occasion to go there for cargoes of hay and grain. After finishing this work, returned again to the Skagit River on November 1 and resumed snagging operations, working from mouth up to a point called the "Cut-off," farther than the regular steamers generally go.

At a point called "Sterling Bend" more than 25 large fir stumps were removed. Some of these stumps being as much as 7 and 8 feet across the top and as firmly embedded in the bottom of the river as they originally were in their native soil.

Large quantities of giant powder was required to remove them. There are yet more of the same kind to be removed when funds are available and stage of water favorable.

On November 28 left the Skagit River for the Snohomish, where operations were continued until December 4, the stage of water being then too high for effective and profitable work except at short intervals. Departure was then taken for Seattle, with the intention of placing the boat in winter quarters. Some necessary work of removing a drift jam in the Duwamish River was done, and on December 11 the boat was laid up at her mooring place and the crew discharged.

The snag boat is getting old and water-logged and is becoming quite difficult to handle, having now a greater draft of water than is desirable in order to ascend these rivers at their low stages, which is undoubtedly the best time to do snagging. She was built in the year of 1882 and will soon need some pretty extensive repairs, as much of her timber below deck is affected with "dry rot." New hog posts, new cylinder timbers, new plank shears, and other extensive repairs will undoubtedly be required before a great while, which I would not advise making on an old and unsuitable hull.

At present it is not safe to trust the boat out in any open water unless it be perfectly smooth, and great care has to be exercised in going from river to river that bad or rough weather is not encountered.

I think a new hull should be built, one of more modern design and improvements; and with the present machinery, with the addition of a big force pump to cut and wash the sand away from embedded snags, a very effective snag boat could be had. If a new hull is built provision can be made for the use of a spud or grouser, by means of which the boat can be held steady on shoal swift water riffles, while chain slings are adjusted to obstructions and the sediment cut and washed away by force pump, an appliance that is very much needed.

If the present machinery were put into a new hull of modern build a very effective snag boat could be had.

Following is a summary of the snag boat's operations for the periods stated:

Snags and drift removed—		
Duwamish River		78
Snohomish River		50
Stillaguamish River		89
Skagit River		763
Sullivan Slough		3
Nooksack River		330
Total		1,313
Largest diameter	feet	8
Smallest diameter	inches	4
Total length	feet	35,363

Leaning trees chopped from the banks—		
Nooksack River		30
Skagit River		19
Snohomish River		14
Total		63
Largest diameter	feet	3¼
Smallest diameter	inches	4
Total length	feet	3,152
Wrecks of steamboats removed, Sullivan Slough		2
Wood manufactured by crew for fuel	cords	4¼

Additional operations consisted of the usual amount of work required to keep the boat, her tackle, gear, etc., in order.

The dull times and the competion of railroads has had the effect of greatly diminishing the business of the steamboats on these rivers, yet the work of the snag boat could hardly be dispensed with. The different streams need annual snagging, otherwise they would soon become so obstructed that steamers could not navigate them for any distance with any degree of safety.

The work done by the snag boat is not only a benefit to the steamboats, but is to logging as well, which is a very important industry on all of these rivers.

On the Snohomish River route from Seattle there is but one regular steamer plying now. Two small steamboats do a profitable passenger business between Everett and the city of Snohomish, making three or four trips daily.

Two little steamboats are regularly employed on the Snoqualmie River from the city of Snohomish up to the head of navigation when business and stage of water permits.

The Nooksack River has but one steamer at present engaged in business on its waters and she does not find regular employment.

On the Duwamish River there is no reguler boat running, but large quantities of hay and hops are frequently freighted from this and its tributary, the White River, by jobbing boats and lighters.

The usual difficulty of obtaining anything like accurate commercial statistics of these rivers is met with again this season. There appears to be no regular method of keeping a record of the business. After considerable research the following figures are submitted as representing the business done by the steamboats on the different rivers in this district at the present time. Number of tons and passengers given represent the business done monthly, which would probably be a fair average during the present depression in business:

Route.	Freight.	Passengers.
	Tons.	
Skagit River via Stillaguamish	2,000	300
Nooksack River	100	50
Snohomish River	800	300
Snoqualmie River	195	125
Between Everett and Snohomish via Lowell	80	2,400

Freight handled by these steamers consists of general merchandise on up trips, and hay, grain, hops, and other farm produce down, as well as manufactured paper and nails from the mills at Lowell and Everett.

Traffic in manufactured lumber and shingles and in hay, grain, etc., from the various tidal sloughs around the mouths of the different rivers is principally done by jobbing boats and barges, of which no account can be procured, and does not enter into the figures stated above.

Very respectfully, your obedient servant,

E. H. JEFFERSON,
Master of Snag Boat.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

As stated by Captain Jefferson, anything like accurate commercial statistics of the rivers tributary to Puget Sound are difficult to obtain, as there is no system of keeping records. He states in a general way the number of boats employed upon the principal rivers. But besides the commerce carried on by boats, these rivers are used for the transportation of enormous quantities of logs which are taken down to be converted into lumber, shingles, and paper.

The multiplication of railways is changing very materially the relative importance of these rivers in respect to certain commodities and lines of business, and the country is in such a transition state that accurate commercial statistics, if obtainable, would have little value in enabling these rivers to be assigned their proper places in the world of commerce.

U U 18.

PLAN FOR IMPROVEMENT OF EVERETT HARBOR, WASHINGTON.

[Printed in Senate Ex. Doc. No. 139, part 2, Fifty-third Congress, second session.]

WAR DEPARTMENT,
Washington City, July 25, 1894.

SIR: Referring to resolution of the Senate dated June 20, 1894, concurred in by the House of Representatives June 27, 1894, directing the Secretary of War to cause a survey and estimate to be made of the cost of dredging the bar at Everett, in the State of Washington, so as to make a fresh-water harbor in or near the river with the greatest depth of water practicable, and to the partial reply of this Department, dated the 12th instant, to the resolution, I have the honor to transmit herewith a letter from the Chief of Engineers, dated the 24th instant, submitting a copy of a report of Capt. Thomas W. Symons, Corps of Engineers, dated the 9th instant, on the subject. The estimated cost of the work mentioned is $372,000.

Very respectfully,

JOSEPH B. DOE,
Acting Secretary of War.

The PRESIDENT, UNITED STATES SENATE.

LETTER OF THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., July 24, 1894.

SIR: Referring to my letter of the 11th instant, in partial response to resolution of June 20 of the Senate, concurred in by the House of Representatives, respecting survey and estimate of the cost of dredging the bar at Everett, in the State of Washington, so as to make a fresh-water harbor in or near the river with the greatest depth of water practicable, I have now to submit the accompanying copy of report of July 9, 1894, on the subject from Capt. Thomas W. Symons, Corps of Engineers.

Captain Symons submits an estimate of the cost of the work mentioned, amounting to $372,000, and states that the harbor will furnish ample accommodations for deep-sea ships at all stages of the tide and the inlet channel will furnish facilities for the passage of sound and river steamers around the peninsula and into the Snohomish at all stages of the tide and for vessels drawing 18 to 20 feet at high tide.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 9, 1894.

GENERAL: I have the honor to submit the following report in compliance with instructions contained in a telegram received June 27, 1894, which reads as follows:

> Captain SYMONS,
> *Worcester Block, 68 Third Street, Portland, Oreg.:*
>
> You will make and submit to this office as soon as possible a survey and estimate of cost of dredging the bar at Everett, Wash., so as to make a fresh-water harbor in or near the river with the greatest depth of water practicable.
>
> CASEY,
> *Chief of Engineers.*

Under date of November 4, 1893, the honorable Secretary of War approved a plan proposed by the Everett Land Company for making certain changes in the channels of the delta mouths of the Snohomish River, and building locks, tide gates, bulkheads and dams, and dredging across the tide flats and in the Old River to make a fresh-water commercial harbor at Everett, Wash.

Also on November 28, 1893, the honorable Secretary of War approved the harbor lines for the harbor surrounding the Everett Peninsula, which harbor lines accord with the harbor plans proposed by the Everett Land Company and approved by the Secretary of War, above mentioned.

The correspondence in regard to this subject, with the instruments of approval, are given in Senate Ex. Doc. No. 53, Fifty-third Congress, second session, and to this document attention is invited for information in regard to the general situation at Everett and the approved harbor plan.

It is taken for granted that the above-mentioned harbor plan and harbor lines shall govern in making the estimates and furnishing the information called for in my telegraphic instructions.

It was not considered necessary to make any surveys in order to prepare the estimates and furnish the information called for. The map of the Everett Land Company, showing the harbor plan and harbor lines approved, contains all data needed, and this having been prepared by an engineer of known ability and integrity, formerly connected with this office, is relied upon. A copy of a portion of this map* reduced one-half in scale, together with vicinity map,* is herewith; upon it is shown the harbor plan and harbor lines approved, and upon it is shown the work estimated for further on in this report.

In order "to make a fresh-water harbor in or near the river with the greatest depth of water practicable," it is necessary to do three things, i.e.: First, to excavate a harbor basin in the shallows and tide lands adjoining deep water near the river's mouth; second, to dredge a channel for this through the tide flats and the Old River to deep fresh water in the Snohomish River, this channel being designed to bring fresh water to the harbor basin and to afford facilities for navigation about the peninsula; and, third, to protect and maintain this harbor and channel across the tide flats by a bulkhead interposed between them and the open waters of the sound.

HARBOR.

It is possible to give this fresh-water harbor almost any depth, but it is believed that a depth of 23 feet at extreme low tide, corresponding to a depth of 26 feet at the mean of the lower low waters and 29 feet at mean low water will be ample, and is therefore considered as fulfilling the condition of giving a harbor with the greatest depth practicable, as called for in my instructions. The estimate is based upon this assumed depth in the harbor basin proposed.

In dimensions this harbor basin could well be limited in length by the deep water of Old Port Gardner on the south and Fourteenth street on the north, near the line of which are situated the sawmills and pulley factory shown on the map. This would be a length of 5,300 feet. A width of 200 feet would give ample accommodation for the present for ships to reach any portion of the dredged basin or the wharves built out to it.

The most suitable location for this long basin would be along and adjacent to the eastern pier-head line in the waterway reserved to the public. This would enable piers and wharves to be built out to it from the main shore, which could be readily reached by the existing railroads.

The amount of excavation required to make this harbor 5,300 feet long, 200 feet wide, and 23 feet at extreme low tide, with side slopes of one on one, is 840,000 cubic yards.

FRESH-WATER INLET CHANNEL.

In order that the harbor just described shall receive fresh water from the Snohomish River and the accompanying benefits therewith, it will be necessary to dredge a channel through the tide flats and the shallows of the Old River to the deep water in the river at Steamboat Slough. The bottom of the Old River and the tide flats have an average elevation of about 5 feet at low tide, so that if no inlet channel were dredged water from above could not reach the dredged channel except at the first of the ebb, and this would be mainly salt water. If a good free channel be dredged across the bar of the tide flats and in the Old River to 6 feet depth at low tide, the water from above would run out through it during the entire ebb, and the water would be comparatively fresh. Such a channel would, besides, furnish a convenient watery highway about the peninsula with a navigable depth at low water of 6 feet and at high water of 21 feet.

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* Omitted.

The estimate provides for this fresh-water inlet and navigable channel 6 feet deep at extreme low water and 100 feet wide at the bottom, with side slopes of one on one.

This channel from Fourteenth street around to the head of Old River would be 29,150 feet long and the amount of excavation involved would be 1,100,000 cubic yards.

BULKHEAD.

In order to protect the dredged harbor and channel across the tide flats from being filled by the sands stirred up by the waves coming in from the deep water of the sound, to quiet the water at high tide, and to better control the flow of the ebb and flood through the channel, it is necessary to construct a dike or bulkhead along the west or open-water side of the channel. This dike can be composed of the material dredged from the harbor and channel deposited behind and supported by a bulkhead of piles and brush. This bulkhead should be built on the western bulkhead line of the approved harbor plan. This should be built to an elevation of full high water. There would be 15,000 feet to be built in water averaging 10 feet deep at high tide from the lower end of Smiths Island to the low-water line, and 2,300 feet from the low-water line out to a depth of 10 feet at low tide.

ESTIMATE.

Dredging in harbor, 840,000 cubic yards, at 13 cents	$109,200
Dredging in inlet channel, 1,100,000 cubic yards, at 13 cents	143,000
Pile and brush bulkhead, 15,000 feet, at $4.50	67,500
Pile and brush bulkhead, 2,300 feet, at $8	18,400
	338,100
Contingencies, engineering, etc., 10 per cent	33,810
Total	371,910
In round numbers	372,000

The work outlined to be done and covered by the estimate is a part of the general plan of the harbor prepared by the Everett Land Company and approved by the Secretary of War.

The harbor will furnish ample accommodations for deep-sea ships at all stages of the tide, and the inlet channel will furnish facilities for the passage of sound and river steamers around the peninsula and into the Snohomish at all stages of the tide and for vessels drawing 18 to 20 feet at high tide.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

U U 19.

ESTABLISHMENT OF HARBOR LINES IN EVERETT HARBOR, WASHINGTON.

OFFICE EVERETT LAND COMPANY OF WASHINGTON,
Everett, Wash., August 9, 1893.

DEAR SIR: I have the honor to forward herewith a letter of the attorney for the city of Everett, inclosing a resolution of the council of said city, which represents that the protection and preservation of the harbor here requires the establishment of harbor lines at this place.

The Everett Land Company, of which I am vice-president and general manager, is the owner of more than three-fourths of all the upland abutting upon said harbor, and, being personally familiar with all of the facts stated in the inclosed resolutions, I take pleasure in indorsing the request of the said city council, believing that the interests of public commerce and the preservation and protection of the harbor at Everett require such action.

And in further support of what the council have stated in their resolution I desire to call your attention to the fact that a transcontinental railroad, to wit, the Great Northern Railway Company, has constructed its main line across the continent, first touching the tide waters of the Pacific at this city, and that the Everett and Monte Cristo Railroad, which by traffic arrangement does the business of the Northern Pacific Railroad at this point, has its terminus at this city, and that large terminal improvements are contemplated by said railway companies; and that, for the purpose of preserving the harbor so that it will best subserve the interests of these two companies, together with the large general commerce now centering here, it is highly important that the U. S. Government should lay harbor lines, including a waterway across certain extensive tide flats in front of said city, from the deep waters of Puget Sound to the mouth of the Snohomish River, which is a large, navigable fresh-water stream for a distance of about 20 miles from said sound, and borders on said city on the north and east sides.

I attach hereto a map* of the city of Everett, together with its harbor, which will show you the situation, and from which you will readily see the importance of the request herein contained.

Very respectfully,

SCHUYLER DURYEE,
Vice-President and General Manager,
The Everett Land Company.

The SECRETARY OF WAR.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS, U. S. ARMY,
October 4, 1893.

Respectfully referred to Capt. Thos. W. Symons, Corps of Engineers, for report.

If, in Captain Symons's opinion, harbor lines should be established at this locality under provisions of section 12 of the river and harbor act of August 11, 1888, as amended and reenacted by section 12 of the river and harbor act approved September 19, 1890, he will please submit to this office a map showing the harbor lines which, in his judgment, should be established by the Secretary of War.

To be returned through the division engineer.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

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* Omitted.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Portland, Oreg., October 10, 1893.

Respectfully returned to the Chief of Engineers, U. S. Army (through Col. G. H. Mendell, division engineer), with report of this date.

T. W. SYMONS,
Captain, Corps of Engineers.

[Fourth indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., October 21, 1893.

Respectfully forwarded to the Chief of Engineers, U. S. Army.

The views expressed by Capt. Symons in report dated the 10th instant, herewith, are concurred in.

G. H. MENDELL,
Colonel, Corps of Engineers,
Division Engineer.

LETTER OF MR. H. D. COOLEY, CITY ATTORNEY.

EVERETT, WASH., *August 9, 1893.*

DEAR SIR: I have the honor herewith to transmit a copy of resolutions passed by the council of the city of Everett, and in compliance with said resolutions request that you cause an order to be entered directing the establishment of harbor lines in the harbor front of and surrounding said city, for the reasons therein stated.

Very respectfully, yours,

H. D. COOLEY,
City Attorney.

The SECRETARY OF WAR.

RESOLUTIONS PASSED BY THE COUNCIL OF THE CITY OF EVERETT, WASH.

Whereas there is a large and increasing commerce at the city of Everett, in the State of Washington, amounting in the aggregate to about 20,000 tons per month; and

Whereas there are numerous sawmills, lumber manufacturing mills, and smelting works within or adjacent to the limits of said city, and at the mouth of the Snohomish River, causing a large amount of débris and other waste products, which are being cast into the said harbor in a manner detrimental to said harbor; and

Whereas wharves and docks are being constructed by private owners in such a way as to cause an irregular line of wharfage, and in such a way as to block up said débris and waste products; and

Whereas no harbor lines have ever been established in front of said city of Everett or in the harbor surrounding said city: Therefore, be it

Resolved, By the council of the incorporated city of Everett, that the preservation and protection of the harbor of said city requires the establishment and laying out of harbor lines and waterways under the direction and by authority of the War Department of the United States; and be it

Further resolved, That the said council of the city of Everett call the attention of the Secretary of War to said conditions recited hereinbefore, and do hereby request, for the purpose of preserving and protecting said harbor, that he cause harbor lines in front of said city to be permanently and definitely established; and be it

Further resolved, That a copy of these resolutions be properly attested by the mayor and clerk of said city and the city attorney be requested to communicate with the Secretary of War and procure such orders as are proper in the premises.

Passed at a regular session of the council this 15th day of August, A. D. 1893.

THOS. DWYER,
Mayor.

Attest:
C. P. CLARK,
City Clerk.
[CORPORATE SEAL.]

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., October 10, 1893.

GENERAL: I have the honor to submit the following report upon the subject of harbor lines at Everett. The general statements contained in the request of the mayor of Everett and the vice-president and general manager of the Everett Land Company I know to be true. It is my opinion that harbor lines should be established at Everett.

This is necessary, particularly in the Upper Snohomish River, back of Everett, where a number of wharves have been built jutting out into the stream. Here the stream is comparatively narrow, and the encroachments by wharves, etc., should be strictly limited. The same is true farther up the river than is shown on the lithograph * map herewith, at Lowell, now a part of Everett.

In connection with this subject of harbor lines, I beg to invite attention to the papers returned herewith, containing the request of the Everett Land Company for authority to construct a harbor at Everett, with my report thereon. The location of harbor lines at Everett is largely dependent upon what action is taken in regard to this request.

The present deep-water frontage of Everett is confined to a short stretch near the Puget Sound Wire, Nail and Steel Company's works. Just north of this point the tide flats of the Snohomish commence and break away out 2 miles to the westerly, and northerly to the Tulalip Indian Reservation, with shallow channels across leading into the river.

The establishment of harbor lines at this deep-water frontage and the building of a lock and harbor basin, as proposed by the Everett Land Company, are so intimately correlated that one can not be properly settled upon and fixed without the other, if both are ultimately located.

If the request of the Everett Land Company be approved, as recommended by me, then it would be desirable to establish the waterway across the tide flats in front of the Everett peninsula mentioned by Mr. Duryee. If it is not approved I can see no reason for establishing the waterway, as requested, unless it be to provide for a similar plan in the future.

Upon the assumption that the plan and request of the Everett Land Company be approved the lines which, in my judgment, should be established by the Secretary of War are approximately shown, as far as the map goes, upon the large blue print* sent with my report upon that request, and may be thus described:

Within the inclosed harbor, in the Old River, across the tide flats, and in the habor basin, the lines should be the "pier head" lines of the harbor channel and the bulkhead lines of the harbor basin.

In the deep water outside the harbor the pier head line should be extended each way from the harbor basin, as shown in red. Above the head of Old River, in the Snohomish River proper, pier head lines should be located providing for the widest possible channel, due regard being had for existing wharves and the rights of property owners to erect others.

I have not sufficient data at present to enable me to accurately locate these lines, which should extend up a little above Lowell, but the general idea of the lines recommended is indicated in red.

Very respectfully, your obedient servant,

T. W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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*Omitted.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 25, 1893.

Respectfully submitted to the Secretary of War.

In the matter of the application of the city of Everett, Wash., and of the Everett Land Company for the establishment of harbor lines at that place, attention is invited to the within report of Capt. Thomas W. Symons, Corps of Engineers, to whom the subject was referred.

Captain Symons has given the matter careful consideration, and recommends the establishment of harbor lines as described in the report and as shown in red on the accompanying map.

I concur in his recommendation.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

WAR DEPARTMENT,
November 28, 1893.

Approved as recommended by the Chief of Engineers.

DANIEL S. LAMONT,
Secretary of War.

APPENDIX V V.

IMPROVEMENT OF WILLAMETTE AND LOWER COLUMBIA RIVERS AND THEIR TRIBUTARIES, OREGON AND WASHINGTON.

REPORT FOR THE FISCAL YEAR ENDING JUNE 30, 1894, WITH OTHER DOCUMENTS RELATING TO THE WORKS. OFFICERS IN CHARGE, MAJORS THOMAS H. HANDBURY AND JAMES C. POST, AND LIEUT. HARRY TAYLOR, CORPS OF ENGINEERS.

IMPROVEMENTS.

1. Mouth of Columbia River, Oregon and Washington.
2. Columbia River between Vancouver, Wash., and mouth of Willamette River.
3. Canal at the Cascades, Columbia River, Oregon.
4. Columbia and Lower Willamette rivers below Portland, Oreg.
5. Willamette River above Portland, and Yamhill River, Oregon.
6. Cowlitz River, Washington.
7. Youngs and Klaskuine rivers, Oregon.
8. Gauging waters of Columbia River, Oregon and Washington.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 9, 1894.

GENERAL: I have the honor to transmit herewith annual reports of the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1894.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

V V I.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON.

The project for this work was adopted in 1884, and contemplated securing and maintaining a navigable channel 30 feet deep across the bar at the mouth of the river by concentrating the ebb currents, distributed over the bar, from Fort Stevens to Cape Disappointment, a distance of 10 miles, measured on the bar. These currents some years produced one good channel, and during others two or three channels across the bar, neither of which was good. To accomplish the desired results a jetty that was to extend from the shore near Fort Stevens across Clatsop Spit toward a point about 3 miles south of Cape Disappointment and slightly convex to the north was proposed. The height and length of the jetty were to be finally determined as the work progressed by the effect produced, but it was to be kept as low and as short as was consistent with the object to be attained, both for reasons of economy and to prevent its being an unnecessary obstruction to the inflowing tides. The jetty was to be built of firmly constructed mattresses covered with rubble and afterwards with random blocks of stone of large size.

In the latter part of 1884 the necessary preparations for commencing the work were made, and early in 1885 active operations began. These consisted in the construction of wharves, buildings, etc., and an elevated railway over the site of the jetty from which the mattresses were to be lowered in place and the stone covering dumped upon them. As the elevated railway advanced the mattresses were laid and ballasted, and these operations were continued until the work was extended 4¼ miles, to a point 3 miles south of Cape Disappointment. The portions of the jetty inshore were also raised as the work advanced. In March, 1893, the results obtained being satisfactory, action was taken to determine the height to which the work should be raised to secure its permanence and maintain the capacity of the newly formed channel. This question was referred to a Board who recommended that the height of the work in its completed state should be 12 feet above datum at the shore and slope to 10 feet at station 122 (1.8 miles) and continue to slope from thence to 4 feet above datum at the outer end. Datum is taken as the mean of the observed lower low waters. This Board also recommended, as an additional protection to the work, the construction of 4 groins on the channel side of the jetty to add to the permanence of the sands accumulating there.

At the close of the last fiscal year the work had been raised to mean high tide for a distance of 2 miles from shore, and beyond this to 4 feet above mean low water, and a straight channel across the bar 29 feet deep at mean low water had been formed, containing within it a narrow depression uniting the 30-foot contours. The distance between the 30 foot contours on the outside and inside of the bar, independent of this depression, was about one-half mile, or 2,640 feet.

The width of the 27-foot channel was about three-quarters of a mile, and that of the 25-foot channel about 1½ miles.

OPERATIONS DURING THE YEAR.

The delivery of rock was continued until the middle of December, when the work was suspended owing to severe weather. About the middle of February the delivery was resumed and continued until the end of March, when operations were again suspended by the completion of the contract for the rock and the near exhaustion of the funds available for the work.

During the year 115,733.8 tons of rock were received, the two outer groins, Nos. 1 and 2, were constructed and the work was raised from its outer end to station 150, or 10,000 feet, to the completed height; from 150 to 105 to 7.5 feet above low water, or average high water; from 105 to 95 it rises gradually from 7.5 to 9 feet above mean low water; from 95 to 40 it rises gradually from 9 to 10 feet, and from 40 to the shore it is at the completed height. From the shore to station 105 the height has been attained by dumping the rock in a narrow ridge. This was considered advisable for greater security against drift, as it was unknown how long the work would be obliged to stand before other appropriations were made. It is possible that the height of this portion of the work may in future be reduced by heavy seas. The unusual height of the water in the Columbia River during the recent rise produced enormous quantities of drift, which, without the precaution taken of giving increased elevation to the work, and the greatest care on the part of those in charge, would have probably wrecked a large portion of the railway over the work. During the heavy gales, from October to December, about 4,000 tons of rock were washed off the outer end of the jetty, reducing its height over the outer 1,400 feet to low water, and from thence to station 228, an additional distance of 800 feet, to 3 feet above low water. Inside of this station there has been practically no disturbance of the rock. The outer 1,800 feet of the railway was also practically destroyed. The rock on groin No. 1 settled 2 feet during the storms referred to. This was afterwards raised to its proper height, and it has again settled 2 feet.

During May and June soundings were made over the outer bar and the shoals in the vicinity of the work and also upon the jetty to ascertain what changes, if any, had taken place during the past year. The condition of the jetty at the end of the year has already been stated. The shoals on both sides of the work have greatly increased both in height and area, as will be seen by reference to the drawing inclosed, which gives the position of the shoals as they existed a year ago and at the present time. The survey of the bar, a copy of which is also inclosed, shows practically no change in the channels. The 30-foot depression across the bar has disappeared while the 29-foot channel is somewhat wider, and the distance measured across the bar between the 30-foot contours has been reduced to 1,500 feet. Apparently this has been caused by the inward movement of the outer contour. The width of the 27-foot channel has increased to 1⅛ miles, and that of the 25-foot channel to 2⅛ miles. In front of the end of the jetty the 24-foot contour has moved seaward about 2,000 feet, and inside this contour toward the jetty the depth has been reduced 5 to 10 feet by drifting sand. On the north side of the channel the 24-foot contour extends about the same distance seaward as before but it has moved somewhat toward the north.

The original estimate of the cost of this work was $3,710,000, and up to the present time $1,687,500 have been appropriated. This leaves to the credit of the work on the original estimate $2,022,500. The progress made, together with the results desired, were so advanced in 1893 that the Board of Engineers estimated that the work could be completed for a sum of $338,180 in addition to that already appropriated. This anticipation still seems likely of fulfillment if the necessary funds are supplied at an early date, and if it is accomplished the total cost of the work will be only $2,025,680, and thus a saving of nearly one-half the original estimate will be made. The present extremely satisfactory condition has resulted mainly from continuous operations upon the work which have been possible by the later appropriations being of sufficient size to enable the work to be carried on without delay, and the present is the first time during five years, except for twenty days in 1890, that the funds have become exhausted and operations have been suspended for that reason. If this suspension be long continued it will add materially to the amount necessary for the completion. The greater portion of the railway over the work, from decay, is nearing the period when it will not be safe unless extensively repaired, and the cost of its maintenance will therefore be greatly increased, even if it does not have to be entirely renewed. Should the latter prove necessary, it would be attended with much difficulty and large expense, for the piling to sustain the track must be driven through the rock and mattresses constituting the jetty. There is therefore great need of an immediate and sufficient appropriation to complete the work, and it is earnestly recommended that the whole of the $338,180 be made available for the fiscal year ending June 30, 1896.

Mr. G. B. Hegardt has continued in local charge of the work and has, as heretofore, performed his duties zealously and intelligently. His report is inclosed and contains additional details of the year's operations.

APPROPRIATIONS.

Act of—	
July 5, 1884	$100,000
August 5, 1886	187,500
August 11, 1888	500,000
February 22, 1890	75,000
September 19, 1890	475,000
July 13, 1892	350,000
Total	1,687,500

Money statement.

July 1, 1893, balance unexpended	$188,810.98
June 30, 1894, amount expended during fiscal year	170,642.08
July 1, 1894, balance unexpended	18,168.90
July 1, 1894, outstanding liabilities	415.00
July 1, 1894, balance available	17,753.90
Amount (estimated) required for completion of existing project	338,180.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	338,180.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF G. B. HEGARDT, ASSISTANT ENGINEER.

OFFICE OF UNITED STATES ASSISTANT ENGINEER,
Fort Stevens, Oreg., June 30, 1894.

MAJOR: I have the honor to submit the following report of operations on the improvement of the mouth of the Columbia River, Oregon and Washington, for the fiscal year ending June 30, 1894.

JETTY TRAMWAY.

No extension to the tramway was made during the year.

Repairs to and the care of the tracks, for the running of rock trains, has been the principal work done.

The period from the latter part of October to about April 1 was a succession of violent storms and gales and the tramway was damaged to a great extent, and particularly so at its outer end.

I have been told by the bar pilots it was the stormiest season experienced during the last sixteen to twenty years.

November 23 to 26 unusually heavy gales prevailed, accompanied by high tides and heavy sea, and the outer end of the tramway suffered a great deal. No examination of the tracks beyond Station 235 could be made until a few days later, because the spray of the breakers was flying across the tracks even at low water.

It was found that the damage done at this time was the washing away of the entire tramway structure between Stations 241-60 and 245-44, a distance of 384 feet. From Station 245-44 to Station 250-00, the original end of the jetty, the tracks remained intact with the exception of a few bents at the very end. Between Stations 241-60 and 239-00 piles were broken off in several bents, but inside from Station 230-00 the tracks were not in the least disturbed.

Where the break occurred is the most exposed part of the jetty, and we have had trouble to hold the tracks there every winter since the tramway was constructed.

As soon as the sea had subsided sufficiently to allow of work being carried on, steps were at once taken to reenforce and strengthen the tracks. The caps and stringers were extra driftbolted, longitudinal braces put in, and ⅜-inch by 2½-inch iron straps placed over both the caps and the stringers for a distance of several hundred feet inshore from Station 239-00, and no further damage was occasioned by the storms until December 20 to 23, when another series of gales of almost greater severity than those in November again occurred.

The damage done, however, was not so serious as in November, and only an additional number of bents washed away between Stations 238-00 and 241-60. The whole structure between these stations had been so weakened by the constant beating of the heavy sea against it that nothing in the way of repairs could be done to secure the tracks and to prevent further damage to the standing and uninjured portion of the tramway; the tracks were cut adrift at Station 238-40, and the tracks inshore from this station strengthened in the same manner as before described.

A large number of piles from Station 150-00 and out were knocked loose and out of place, but were secured before they were broken off. About the middle of January the worst storm of the season struck this place and continued for five days, the velocity of the wind during these days being from 70 to 90 miles per hour. This time more damage was done, and a number of bents washed away from the standing end of the tramway, and it again became necessary to cut adrift the damaged portion of the tracks at Station 235-00.

In February and March more piles were broken off as far in as to Station 232-48, but since that time no damage has been done to the tramway tracks by the storms.

The original end of the tramway was at Station 250-40, but the last two bents were carried away shortly after the rock had been placed, so that Station 250-00 has been considered as the end of the jetty and the tramway.

It will be seen that nearly 2,000 feet of track have either been entirely washed away or badly damaged since November last, Station 232-48 being now the end of the tramway.

Portions of the damaged tracks are still standing and the entire part between Stations 249-88 and 246-84. This is where a third track had been added to the tramway and the mattress work made 70 feet wide and a very large amount of rock placed.

Before the winter storms set in the rock in the jetty had already been raised to the height established by the Board of Engineers, from the outer end and inshore for a distance of 1.89 miles, and this part of the jetty considered as completed, and the damage to the tramway was not of so serious a nature as it would have been had it occurred at an earlier date.

The rails on the outer part of the tramway had been taken up for use in the groin tracks, from the north track between Stations 235 and 250 and from the south track between Stations 242 and 250, so that comparatively few rails were lost.

During the unprecedented freshet in the Columbia, in the early part of June, immense quantities of drift were brought down and large portions lodged against the jetty. By constant watchfulness and the sawing up and pulling out of the drift, the only damage done to the tramway was the breaking off of one pile near Station 207-00.

Fortunately southerly winds prevailed during the greater part of the time during which the most of the drift came down and kept it away from the jetty.

The usual yearly straightening of the tracks had to be attended to and was done during suspension of rock delivery in January.

From the shore and out to Station 156-00 the rails were taken up and relaid for the greater part of the distance, and the first 2,000 feet entirely respiked.

A new railroad crossing was put down where the pile-driver tracks join the main tracks, the old one being in bad condition.

While running rock trains it had been necessary, as heretofore, to employ three men to take up the creeping of the rails and keep the tracks in good order.

The first part of the tramway has now been standing since 1886, and during the last three years received extensive repairs.

Its condition of course becomes worse with every year, and will not be safe to use much longer without being practically rebuilt. The rails, from the constant exposure to the salt air and spray from the sea, are getting badly corroded and are about ready to be condemned as unfit for further use.

JETTY.

The mattress work was completed in 1892, and no mat-sinking in the jetty proper has been done during the year.

The amount of rock received and placed on the jetty and groins during the fiscal year was 115,733.8 tons, and was furnished by Maxwell & Huber, Spokane, Wash., under contract of March 6, 1893.

The rock received was distributed over the jetty and on the groins at the following places: Between Stations 150 and 250, the end of the jetty, 57,462 tons; between Stations 30 and 150, 49,750 tons; in groin No. 1, at Station 228-00, 5,283 tons, and in groin No. 2, at Station 156-00, 3,238.8 tons.

By the revised project of the Board of Engineers, approved June 9, 1893, the jetty when considered as completed, the top at the shore end, Station 25-80, should be at reference 12 above datum plane, and should slope thence to reference 10 at Station 122-00, 1.8 miles; thence to the reference 4 at the outer end.

The rock received during the fiscal year has been placed in accordance with the project, and the jetty between Stations 150-00 and 250-00, 10,000 feet, raised to the established references, and is considered as completed.

The jetty between Stations 25-80 and 150-00 has been raised to the following heights: From Station 25-80 to Station 40-00 the rock is up to reference 12 above datum plane, mean lower low waters; from Station 40-00 to Station 95-00 it is practically up to within 2.5 feet of the established height for the entire distance, and from Station 95-00 the rock slopes from reference 9 to reference 7.5, mean high water, at Station 105-00. From station 105-00 to Station 150-00 the top of the jetty is practically up to mean high water.

The crest of the jetty from Station 25-80 to Station 105-00 is, however, very narrow, because the rock placed here during the last months of rock delivery was dumped to increase the height as much as possible without increasing the base.

Rock delivery for the winter was suspended on December 16, and nearly the whole force discharged, only sufficient number of men being retained to make necessary repairs to the plant and tramway tracks.

There still remained at this date 28,615.2 tons of rock to be taken on contract of March 6, 1893. On February 14 delivery of rock was again resumed, and all the rock taken and contract completed March 30, and all hands laid off, with the exception of a small party retained for surveying purposes and two watchmen.

During the month of March 19,584.3 tons of rock was received and discharged, and was the largest amount received in any one month during the year, despite the unusually rough weather, and this amount has been exceeded only twice during the progress of the work, September, 1891, 21,868 tons, and October, 1891, 20,255 tons.

At Stations 52 and 88, the locations of the two groins still to be constructed for a distance of about 300 feet at each place, the rock in the jetty had been left low to permit of the driving of the connection piles of the groins with the main tracks with greater ease, the driving next to the jetty being through the rocks.

During the suspension of rock delivery in January, the necessary piles were driven to allow the "crossing" timbers of the groins to be placed, and when rock was again received, in February, these low places were filled up and the rock raised to the established height, as the putting in of the railroad crossings for the groin tracks would prevent additional rock to be placed there.

All the rock placed during the year between Stations 25-80 and 52-00 was dumped on the north or river side of the tracks, because the bents of the tramway between these stations are only 10 feet apart and do not admit of large blocks being dumped between the tracks, as is done where the bents are 16 feet apart, and also because it affords the best protection against the logs and drift carried down by freshets in the river.

This drift lodges mostly against this stretch of the jetty, and when there is any swell on either breaks the piles off or knocks them out of place.

The drift brought down by the freshet in the Columbia, during the early part of June, was the heaviest yet experienced, and but for the increased height of the rock in the jetty considerable damage to the tracks would no doubt have been done.

As has elsewhere been stated, the fall and winter months were a succession of storms of unusual severity. During these storms the outer end of the jetty was subjected to the full force of the sea and a large amount of rock was washed off.

Where the jetty is protected by the large sand spit on the south side the waves are broken and their force spent before reaching the jetty. It may be said that inshore from Station 210 no disturbance to the rock work has taken place, and only to a small extent between Stations 220 and 230.

From Station 230 and out to the end, however, the storms caused a large amount of rock to be washed off the top of the jetty, and it is estimated, from cross sections, that the rock thus washed off amounted to in the neighborhood of 4,000 tons.

Inshore from Station 225 the rock remains practically as it was at the time of placing it, some of the top rocks only having been swept off in a few places between Stations 210 and 225. From Station 230 and out to the end the rock is now only up to about 1 foot above datum plane, or practically at the height it was after the winter storms of 1892–'93, so that the rock placed on the jetty this year outside of Station 230 was washed off by the storms in October–December.

No disturbance of the rock work has taken place since January, it being found, from measurements taken for cross sections of the jetty, to be at the present time at the same height as it was on December 19.

Frequent measurements have been taken during the year of the height of the rock in the jetty, but there have been no signs of settling or sinking of the rock.

The sands on each side of the jetty were located in June, by sextants, on a run-out of the tide, of about 2 feet below datum plane, and show considerable increase in area since last year.

On the south side the spit has extended toward the end of the jetty and now joins it at about Station 230, and at its lower end there is an addition of about 3,000 feet to the south.

At its lower end it has also moved about 600 feet nearer to the low-water shore line of the beach, leaving a channel, at extreme low water, about 600 feet wide between the spit and the beach. This channel, from some distance north of the Point Adams Light-House to near its lower end, carries from 10 to 16 feet of water, with strong currents running through it, and particularly so on ebb tide. At certain stages of the tide this channel is the only outlet for the flood water from the large pocket near the root of the jetty.

At the lower end of the spit this channel is nearly closed by a sand bar with a depth of only a couple of feet at low water.

The large pocket of water south of the jetty and near its root has about the same depth as at the time last survey was made, October, 1893, though the spit itself has made out, reducing the area of the pocket.

The southern limit of the large sand spit, on the south side of the jetty, toward its lower end, has been forced several hundred feet to the north, caused probably by the heavy surf constantly beating against it at its junction with the beach for the larger portion of the winter and spring, and no doubt accounts for the large extension of the spit below this point.

Though this spit has not greatly increased in area, it has built in height considerably and shows a much larger area bare at a certain stage above low water. Parts of it are bare at an elevation of 6 feet above the plane of reference, mean lower low water, and the largest portion of it at 5 feet.

On the north side of the jetty the accumulation of sand also shows a decided increase and makes a practically continuous spit from Station 110 and out to Station 220. At its widest part, opposite Station 120, the spit has moved out about 700 feet, as compared with last year.

Since the jetty has been raised to its present height the tendency of the tide to flow with great velocity across the line of the jetty, which trouble was experienced principally in the first mile and one-half, has been practically checked, with the exception of on the first of the ebb, on tides above the average height.

The ebb water now flows nearly parallel to the jetty and the currents from it have caused some scouring away of the sand near the jetty, from its root and out to about Station 50 and between Stations 80 and 100, but does not exceed 3.5 feet in the deepest place and a little over 2 feet on the average.

The construction of the two remaining groins, at Stations 52 and 88, will no doubt obviate this difficulty and cause a decided shoaling near the jetty.

The accumulation of sand between the two groins already constructed has been more rapid than elsewhere. The sand has filled in close up to the jetty and in places is up to the level of the rock.

GROINS.

According to the project of the Board of Engineers, approved June 9, 1893, four low groins were to be built out from the main jetty—one near Station 52–00, 1,000 feet long; another near Station 88–00, 1,000 feet; another near Station 151–00, 600 feet long, and the fourth near Station 228–00, 500 feet long. All to slope on the top from datum level at the jetty to the bottom of the river at the outer end. The rock to rest upon brush mattresses about 2½ feet thick and 40 feet wide.

For convenience the groins have been numbered 1, 2, 3, and 4, No. 1 being near the outer end of the jetty and No. 4 the one next to the shore.

Groins 1 and 2 were completed last fall.

The one projected to be built out from Station 151–00 was put in at Station 156–00 to get it in deeper water, the sand spit at Station 151–00 having built up so rapidly as to be bare at low water, close up to the jetty, at the time the construction of the groin was to be commenced.

As soon as the material for the construction of the two outer groins was received the pile-driver was at once run out and set to work, July 26.

Groin No. 1 was the one first commenced, but, owing to its exposed position to the heavy sea running in over the spit at the end of the jetty, driving was very slow, and it was not until September 1 that the tracks were completed and ready for the sinking of the mattresses.

The pile-driving for groin No. 2 commenced on September 8 and was completed in the early part of October. The last mattress for this groin was sunk November 8.

The construction of the groin was greatly retarded by the bad weather experienced.

The average cost per linear foot of the tracks for groins 1 and 2 was $8.69; for groin No. 1 it was nearly $10 per foot, or double that of the main tracks.

The cost of the mattress work for both groins was $5 per linear foot.

In the construction of the two groins were used 690 cords of fascines and 8,521.8 tons of rock; of the latter 5,283 tons in groin No. 1 and 3,238.8 tons in groin No. 2.

The mats in groin No. 1 were sunk in an average of 6 feet of water, at low water, and those in groin No. 2 about one-third in 8 feet of water and one-third on the sands bare at zero.

After the storms in October-December the rock in groin No. 1 showed a settlement or washing off of about 2 feet, and in February 200 tons of rock was dumped on it to bring it to its original height.

Measurements taken in groin No. 1 in the early part of June showed a further settlement of about 2 feet, caused probably by scour from the strong currents during the freshet in the Columbia.

The rock in groin No. 2 remains at the same height as at the time of placing it.

For groins 3 and 4 the first twelve piles were driven at each place, which permits of the railroad crossings being put down and the constructions of the groin tracks to proceed without interruption to the running of rock trains when the work is again started up.

The effect of the groins already constructed has been to cause the sands to build up and increase in area, and notably so below No. 2 groin.

Fourteen piles were washed away from near the end of groin No. 1 during the winter storms. These have not yet been replaced.

SHORE TRESTLE.

No work was required to be done to this during the year, with the exception of the ordinary care of the tracks.

WHARVES.

The storms in December and January were followed by extreme high tides, with very heavy swell, and the wharves, tracks, and connections were damaged to some extent.

A large number of piles in the tracks were undermined and washed away or broken off by floating logs, and the gridiron for storing the small rock used in sinking mattresses destroyed.

This gridiron was built in August in connection with the mattress work for the groins, and was 24 by 60 feet.

In the connection between the new and the old wharves one bent of piles was carried away.

The necessary repairs were made before rock delivery was resumed in February.

SHORE REVETMENT.

In November about 800 feet of the track were either washed away or undermined, and the height of the rock lowered several feet in places.

The piles for this track in the portion damaged had only been dug into the ground, and in anticipation of possible injury to it the rails had been taken up to be used elsewhere.

No attempts have been made during the last two years to keep this track in repairs.

PLANT.

The whole plant has been kept in good repair during the year. All repairs to the plant have been made on the work and in the workshop of the place.

Dump cars.—Five of the geared dump cars had the ironwork scraped, after which this, as well as the woodwork, was thoroughly painted. Twenty-six new car boxes were made and a large number repaired. The woodwork in the swing frame of the geared cars had become badly worn, and had to be renewed in 19 cars.

Locomotives.—The ordinary running repairs during the working season were attended to.

During the suspension of rock delivery in January, locomotives Nos. 2 and 3 were overhauled and put in good repair. These locomotives also had new trailing truck springs made for them and put in.

Four locomotives had new smokestacks made or the old ones practically renewed.

Derricks.—These have been kept in good repair and painted. In January two of the derricks were taken down to have the ironwork examined and painted. One new boom and mast were made as a reserve in case of breakdown.

The wooden frictions of the hoisting engines were turned off and trued and the machinery slightly repaired.

Pile-driver.—The engines of the driver were given some small repairs before set to work on the groin tracks, and the pump used to hydraulic down the piles thoroughly overhauled.

Tug.—In January the steam tug *George H. Mendell* was laid up for four days for general overhauling and the cleaning of the machinery and boiler.

Canvas was put under the pilot house to stop the leakage of rain water in the cabin underneath.

The tug was put on the beach, and the bottom of the hull scraped and given a coat of copper paint.

A hand rail was put round the whole upper deck, principally as a safeguard when using the tug for surveying on the bar.

Barges.—All the barges were more or less repaired while engaged in carrying rock from the quarry, the minor repairs being mostly to the decks and guards.

The four small and oldest barges received extensive repairs during the year. All of them had practically new decks put on, and two of them were hauled out in Portland for the calking of the bottom and sides below water line.

Before commencing to take rock in February last, it was found necessary to haul out two of the large-size barges, Nos. 7 and 9, to be calked before they could be put on the run.

New sheathing on the decks was put down on barges Nos. 8 and 10, besides the patching of all the others.

Quarters and buildings.—The foundations of the barracks and the mess storehouse had to be reinforced, as they showed signs of settling. The quarters and other houses around the parade ground were whitewashed.

SURVEYS.

Since April 1 the only work carried on has been that of surveying, and this has occupied the time of a small party up to the end of the fiscal year. The first surveying done was the locating of the fish traps bordering on the channel lines in Bakers Bay. Later on, ranges were established to define these channel lines, and consist of dolphins driven at convenient distances on the lines of the channel.

Soundings were also taken in the channel inside of Sand Island, Bakers Bay, and out through what is called the "cut-off," between the lower end of the island and Cape Disappointment.

Some shoaling has taken place at the head of the island, but the greatest change has occurred in the "cut-off." As late as last November there was a good 13-foot channel at low water, but this was practically closed by the winter storms, and in February carried only 5 to 6 feet at low water.

The swell, which during the winter storms breaks with great violence upon Peacock Spit, was this past winter reported to have been much greater than during any previous year and forced the sand over into the channel and reduced its depth by 7 to 8 feet.

In April this channel gave indications of opening up again, and soundings taken in May showed a very narrow channel with 9 feet at low water, and has since increased in depth, and some in width, until there now is over 10 feet.

The location of the present channel, however, is nearly one-half mile farther to the eastward than that of last year.

Lines of soundings, perpendicular to the axis of the jetty and 500 feet apart on the north side, were run as far out as to the channel buoys.

Considering separately the stretch from the wharf to the large sand spit opposite Station 100-00 of the jetty, where the greatest changes have taken place, the soundings show an increase in depth, as compared with similar lines of soundings taken in 1892.

This increase in depth is noticeable mostly in the portion nearer to the wharf, and in places amounts to as much as 10 feet, but the scour decreases as the sand spit is approached.

This refers to the area about 1,000 feet away from the jetty, as inside of this distance a decided shoaling has occurred in places.

There still remains the narrow space along the north side of the jetty, where the water is deeper than farther away.

Below the sand spit and out toward the end of the jetty the sands are now close up to the rock in a continuous spit to Station 210–00, and outside of this great shoaling has taken place, due, no doubt, in part to the two groins.

Near the outer end of the jetty the soundings show deeper water by from 5 to 10 feet, though at its very end it has shoaled some. For the whole distance from the wharf to the end of the jetty the water near to the buoys has deepened considerably, moving the 24 and 30 foot curves slightly nearer to the jetty.

On the south side the winter storms have banked the sand higher up and nearer to the jetty, closed up the space which existed last year all the way out from Station 155–00 and made a continuous sand spit, which now joins the jetty at Station 230–00.

Near the end of the jetty the depth near it is greater than it was, but only by a few feet, though it has shoaled farther away.

Comparing the present bar survey with that of last fiscal year, great changes are found to have taken place in the spit in prolongation of and southwest of the jetty. The soundings show a great shoaling, and over a large portion of it by from 5 to 10 feet, and more so on its outer or westerly side than nearer to the jetty.

A little distance from the end of the jetty there is a small space not covered by soundings. The water here is very shoal and can not exceed a few feet at low water. Attempts were made to take soundings there in the surfboat of the Life-Saving Service here, but it had to be given up, the sea breaking there at all times.

In the channel itself, across the bar, there is very little change as compared with last June. There was at that time a very narrow strip through which there was 30 feet of water, with 29 and 28 feet soundings on each side of it.

The present survey gives a channel depth of 29 feet, at the average of the lowest low waters, with a distance of about 1,500 feet between the 30-foot curves on either side of the bar, or practically the same distance which existed last year, with the exception of through the narrow strip where these curves met.

There is very little change in the 24 and 30 foot curves on the bar. The southerly storms, which prevailed for such a long time last winter, have slightly forced the 30-foot curve to the north, near the channel, and banked up the sands on the spit to the right of the channel, moving the 24-foot curve about 2,000 feet to the westward.

Taking into consideration the unusual severity of the winter and spring, with almost continuous southerly gales for more than three months and the exposure to the full force of the ocean, I think it is a remarkably good showing that the depth over the bar has practically maintained itself.

Despite the severity of the weather during the fall and winter months, the time of the arrival and departure of the greatest number of ships, there was no detention or delay caused to the shipping.

Slow progress was made with the bar survey on account of the great freshet in the river, the current not being sufficiently checked to take soundings except during two or three hours before high water.

MISCELLANEOUS.

To accompany this report the following drawings are sent:

Plan and profile showing the extent of jetty construction June 30, 1894, and survey of the mouth of the Columbia River, made during May and June.

Very respectfully, your obedient servant,

G. B. HEGARDT,
Assistant Engineer.

Maj. JAMES C. POST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following statistics bearing upon the improvement of the mouth of the Columbia River have been collected from the sources indicated:

[From collector of customs, Astoria, Oreg.]

Arrival and clearances of vessels at Astoria, Oreg., during the year ending December 31, 1893.

Vessels.	Coastwise.		Foreign ports.				Total.	
			American.		Foreign.			
	No.	*Tonnage.*	*No.*	*Tonnage.*	*No.*	*Tonnage.*	*No.*	*Tonnage.*
Arrived	480	407,837	17	9,778	56	72,433	553	490,048
Cleared	445	440,423	23	15,005	12	18,786	480	474,214

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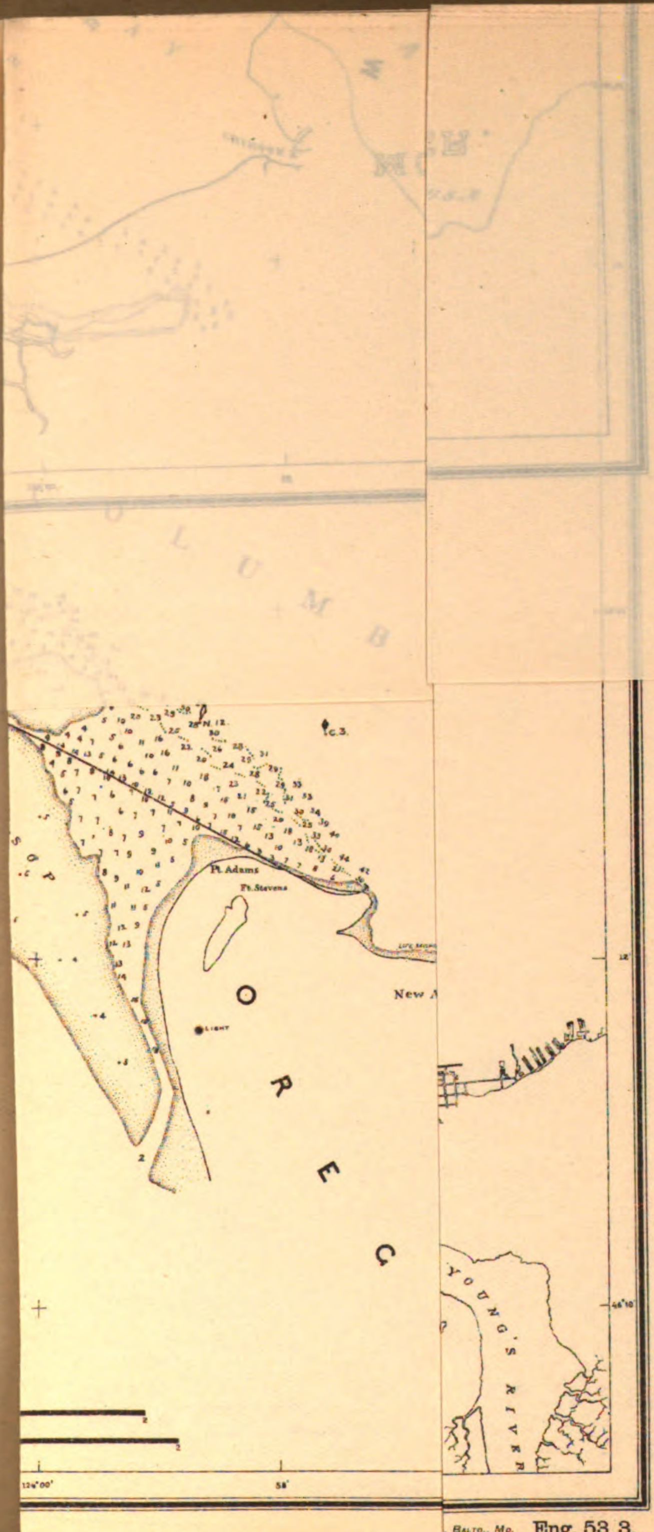

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Commerce for year ending December 31, 1893.

Exports	$127,521.00
Imports	117,048.07
Duties collected	106,952.19

Registered tonnage over Columbia River Bar for year ending December 31, 1893.

INWARD.

Month.	Deep-sea vessels.						Steam.				Coasters.		Total tonnage.	
	American.		British.		German, etc.		American.		Other flags.		American.			
1893.	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
January	1	1,462	5	7,797	1	826	26	21,351	1	157	6	2,287	40	33,880
February	2	2,890	6	8,230			15	14,891			4	1,452	27	27,463
March	1	1,469	2	2,092			18	16,026			3	1,323	24	20,910
April	1	1,305	2	2,643			16	14,800			4	951	23	19,699
May			2	3,415			17	14,910	2	1,122	5	2,447	26	21,894
June	2	2,083					14	13,476			2	741	18	16,300
July	1	1,380	1	1,113			14	13,328	1	561	4	1,679	21	18,061
August	1	1,585	4	5,242			10	11,375	2	1,122	1	419	18	19,743
September	3	5,275	11	17,625	1	1,495	13	10,686			2	809	30	35,890
October			5	8,065			11	10,518			2	173	18	18,756
November			17	27,120	2	2,697	14	13,053			3	966	36	43,836
December	1	1,474	7	10,559			11	12,519			1	419	20	24,971
Total	13	18,923	62	93,901	4	5,018	179	166,933	6	2,962	37	13,666	301	301,403

OUTWARD.

1893.														
January	2	2,681	9	13,995			20	19,010			3	1,135	34	36,821
February	1	1,181	5	9,223	2	2,200	13	13,766	1	157	5	2,099	27	28,626
March	1	1,402	5	6,827			19	15,429			3	1,030	28	24,688
April	1	1,200					13	14,137			4	1,767	18	17,104
May	1	1,488	6	7,856			16	14,761	1	561	2	921	26	25,587
June	3	3,858					16	13,198	1	561	3	1,401	23	19,018
July	1	1,462	1	803			12	14,160	1	561	3	1,866	18	18,852
August	2	2,728					9	11,632	2	1,122	2	1,007	15	16,489
September			4	5,571			11	10,602			2	810	17	16,983
October	2	3,481	8	11,954	1	1,495	10	9,737			1	147	22	26,814
November	2	2,161	9	14,330	1	1,179	14	14,207			1	452	27	32,329
December	2	2,003	15	22,882	1	1,518	9	10,932			1	339	28	37,074
Total	18	23,645	62	93,441	5	6,392	162	161,571	6	2,962	30	12,974	283	300,985

Comparative statement of deep-sea tonnage.

INWARD.

Year ending—	American.		British.		Norwegian.		German, etc.		Total.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
July 31—										
1887	9	11,839	130	113,837			2	1,475	141	127,151
1888	8	10,656	95	117,072	2	2,137	1	1,726	106	131,591
1889	9	13,241	77	92,483	2	1,744	4	3,876	92	111,344
June 30—										
1890	6	8,336	47	61,812			1	974	54	71,122
1891	9	12,393	73	97,954			3	3,989	85	114,336
1892	11	17,603	84	113,793			7	7,949	102	130,345
1893	15	19,323	67	89,615			5	6,277	87	115,215
December 31, 1893	13	18,923	62	93,901			4	5,018	79	117,842

OUTWARD.

July 31—										
1887	7	9,280	111	119,716			1	851	119	129,847
1888	3	3,857	98	122,344	2	2,137	2	2,350	105	130,688
1889	12	16,611	75	89,731	2	1,744	4	3,976	93	112,062
June 30—										
1890	5	8,050	52	67,428			1	974	58	76,452
1891	9	12,393	67	90,683			4	4,963	80	108,039
1892	7	10,494	82	109,386			7	7,949	96	127,829
1893	17	24,328	68	91,396			5	6,277	90	122,001
December 31, 1893	18	23,645	62	93,941			5	6,392	85	123,978

Principal exports during the year ending December 31, 1893.

	Wheat.	Flour.	Salmon.	Total.
	Centals.	*Barrels.*	*Cases.*	*Tons.*
To foreign ports	3,552,989	270,970	11,726	195,156
To domestic ports	329,731	39,827	....	20,469
Total	3,882,720	310,797	11,726	215,625

Arrivals and clearances of vessels at Portland, Oreg., during the year ending December 31, 1893.

[From collector of customs at Portland, Oreg.]

	Coastwise.		Foreign ports.				Total.	
			American.		Foreign.			
	No.	*Tonnage.*	*No.*	*Tonnage.*	*No.*	*Tonnage.*	*No.*	*Tonnage.*
Arrived	158	183,170	23	14,439	63	84,211	244	281,820
Cleared	130	154,454	30	27,478	75	105,118	235	287,050

Commerce for year ending December 31, 1893.

Exports	$4,669,618.00
Imports	969,165.00
Duties collected	358,356.08

Comparative statement of principal exports from Portland for the past ten years.

[From annual report of the Chamber of Commerce of Portland, Oreg., for year ending December 31, 1893.]

Year ending—	Wheat.			Flour.		
	Foreign.	Domestic.	Total.	Foreign.	Domestic.	Total.
	Centals.	*Centals.*	*Tons.*	*Barrels.*	*Barrels.*	*Tons.*
July 31—						
1884	2,276,809	311,941	129,438	334,534	218,846	55,338
1885	3,147,902	521,834	183,487	198,207	182,316	38,052
1886	3,971,756	1,349,740	266,075	353,869	187,763	54,163
1887	3,042,316	711,872	187,709	383,773	137,908	52,168
1888	3,203,108	1,259,263	223,119	486,456	157,655	64,411
1889	2,689,686	559,953	162,482	510,875	144,151	65,503
1890	1,752,879	343,690	104,828	411,751	111,681	52,343
1891	2,937,653	1,213,562	207,561	491,135	147,756	63,889
1892	3,531,919	1,016,194	227,406	377,711	151,359	52,907
1893	3,067,406	750,739	190,907	414,564	164,496	57,906
December 31, 1893	3,390,103	756,433	207,327	395,961	166,062	56,202

Year.	Salmon.			Year.	Salmon.		
	By river.	By rail.	Total.		By river.	By rail.	Total.
	Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*	*Tons.*
1884	15,226	5,349	20,575	1889	7,155	7,489	14,644
1885	12,361	8,063	20,424	1890	2,957	9,708	12,665
1886	8,969	9,442	18,411	1891	4,254	7,879	12,133
1887	5,963	10,378	16,341	1892	5,318	11,155	16,473
1888	3,351	9,996	13,347	1893	3,943	8,202	12,145

Shipments from Portland via Columbia and Willamette rivers during the year ending December 31, 1893.

Articles.		Number.	Tons.
Flour	barrels	497,629	49,763
Wheat	bushels	6,889,877	206,696
Oats	do	131,362	1,970
Barley	do	56,158	1,689
Mill stuffs			3,545
Salmon	cases	118,303	3,943
Wool	pounds	3,039,833	1,520
Hides	do	2,382,469	1,191
Flaxseed	do	714,924	357
Hops	do	303,057	151
Lumber	M feet	27,977	41,965
Total			312,790

In addition to the above, miscellaneous commodities of a total value of $373,884 were shipped by river from Portland in 1893.

V V 2.

IMPROVEMENT OF COLUMBIA RIVER BETWEEN VANCOUVER, WASHINGTON, AND MOUTH OF WILLAMETTE RIVER.

The project for the improvement of this portion of the river, adopted in 1892, provides for the construction of a dam connecting the head of Hayden Island with the Oregon shore. At low water about 36 per cent of the volume of the river passes behind the island, and the dam was to be built to a height of 4 feet above this stage to increase the volume in the main channel, and by the additional scour to remove a bar opposite the island upon which there was but 9 feet, so that vessels drawing 20 feet or more could ascend to Vancouver.

The construction of the proposed dam was undertaken during the previous fiscal year under a contract with Borthwick & Davison, entered into in September, 1892. The dam was to be 2,900 feet long, and be given a maximum width of 30 feet at the base and 6 feet at the top. The contract required the completion of the work January 6, 1893. The contractors, failing to prosecute the work with the necessary energy and proper management, had not completed the dam in the following April, when the summer rise in the Columbia began, and the work was flooded. At this time the bank revetment and all but 60 feet of the dam next the island was completed. The work remained submerged until October, when the water receded sufficiently to expose the top of the dam. An examination was then made and it was ascertained that the incomplete portion of the dam had been destroyed, that the head of the island had been carried away, and that there existed a gap between the completed portion of the dam and the island 470 feet wide, and from 30 to 39 feet deep. It might here be stated that the head of the island was washing away before this work was commenced, and it was hoped that, by the construction of the dam and a revetment extending 125 feet on each face, the scour might be arrested, and the head of the island be made permanent.

The contract with Borthwick & Davison was annulled by authority of the Chief of Engineers, February 9, 1894. The total expended up to this time was $25,177.36, leaving a balance of $7,822.64 for the continuation of the work. This amount being insufficient to close the gap that had been formed, it was considered advisable, in order to prevent further scour while awaiting additional funds, to expend the balance on hand in thoroughly revetting the head of the island and in laying a sill, or foundation of a dam, across the gap from the end of the completed part of the dam to the island. For this purpose bids were requested, and after being duly opened a contract was made with Robert Smith, February 17, 1894. Work was commenced March 4, and continued to April 12, when operations were closed by high water. Up to this time 27 piles had been driven in the line of the dam, and the head of the island was revetted for a distance of 200 feet on the main channel side of the island, and for a distance of 500 feet on the side next the dam. This revetment was composed of brush, heavily weighted with stone, and extended from the top of the island to the bottom of the channel alongside it. A portion of the top of the island at the head was also covered.

At the close of the year the entire work, including the island, was covered by water to a depth of from 15 to 18 feet, and it is impossible to ascertain its condition. Under these circumstances no estimate is submitted for closing the gap, as the necessary data can not now be obtained. The Columbia River during the months of May and June has been greater in volume than ever heretofore known, and it is not improbable that the unfinished work has suffered further damage, and that there has been increased scour. As soon as the condition of the work can be ascertained, after the water has receded, a plan and estimate for completing this work will be submitted.

This work is in the collection district of Willamette. The nearest port of entry is Portland, Oreg., 17 miles distant by water, 5 miles by land. The nearest light-house and works of defense are at the mouth of the Columbia River, 103 miles distant.

APPROPRIATION.

Act of July 13, 1892	$33,000

Money statement.

July 1, 1893, balance unexpended	$8,094.24
June 30, 1894, amount expended during fiscal year	3,973.41
July 1, 1894, balance unexpended	4,120.83

Abstract of proposals for repairing dam at head of slough behind Hayden Island, Columbia River, received and opened by Lieut. Harry Taylor, Corps of Engineers, on the 30th day of January, 1894.

No.	Name and address of bidder.	7,240 linear feet piles.		16,450 feet, B. M., lumber.		181 bolts.		334 pounds washers.	
		Per foot.	Total.	Per M.	Total.	Each.	Total.	Per pound.	Total.
		Cents.				Cents.		Cents.	
1	John Kiernan, Portland, Oreg	8	$579.20	$16.00	$263.20	20	$36.20	4	$13.36
2	Pacific Bridge Co., Portland, Oreg.	11	796.40	12.00	197.40	14	25.34	3¼	10.85
3	Robert Smith, Portland, Oreg	7¾	561.10	11.00	180.95	13	23.53	3	10.02
4	Joseph Paquet, Portland, Oreg	9½	687.80	12.00	197.40	21	38.01	3	10.02
5	Perry Hinkle, Portland, Oreg	10	724.00	12.00	197.40	20	36.20	3	10.02
6	John E. Howard, Portland, Oreg	12	868.80	15.00	246.75	18	32.58	2	6.68
7	Bronnon & Antonello, Portland, Oreg	13	941.20	16.00	263.20	28	50.68	6	20.04
8	Ewing & Normile, Portland, Oreg.	9	651.60	12.00	197.40	24	43.44	4	13.36
9	American Bridge and Contract Company, Portland, Oreg	13	941.20	13.00	213.85	26	47.06	6½	21.71
10	J. L. Robertson & Co., Portland, Oreg	7	506.80	12.00	197.40	15	27.15	2½	8.35

Abstract of proposals for repairing dam at head of slough behind Hayden Island, Columbia River, etc.—Continued.

No.	Name and address of bidder.	1,000 pounds boat spikes.		900 pounds wire.		3,400 tons rock.		850 cords fascines.		Aggregate of bid.
		Per pound.	Total.	Per pound.	Total.	Per ton.	Total.	Per cord.	Total.	
		Cents.		*Cents.*		*Cents.*				
1	John . Kiernan, Portland, Oreg	5	$50.00	4	$36.00	74	$2,516.00	$2.90	$2,465.00	$5,958.96
2	Pacific Bridge Co., Portland, Oreg	3¾	37.50	3½	31.50	54	1,836.00	2.55	2,167.50	5,102.49
3	Robert Smith, Portland, Oreg	3	30.00	2¾	24.75	55	1,870.00	2.25	1,912.50	4,612.85
4	Joseph Paquet, Portland, Oreg	4	40.00	4	36.00	60	2,040.00	2.70	2,295.00	5,344.23
5	Perry Hinkle, Portland, Oreg	4	40.00	4	36.00	62½	2,125.00	2.40	2,040.00	5,208.62
6	John E. Howard, Portland, Oreg	3	30.00	6	54.00	65	2,210.00	2.95	2,507.50	5,956.31
7	Bronnon & Antonello, Portland, Oreg	7	70.00	7	63.00	75	2,550.00	2.95	2,507.50	6,465.62
8	Ewing & Normile, Portland, Oreg	4½	45.00	3¼	29.25	58	1,972.00	2.35	1,997.50	4,949.55
9	American Bridge and Contract Co., Portland, Oreg	6½	65.00	6½	58.50	65	2,210.00	2.73	2,320.50	5,877.82
10	J. L. Robertson & Co., Portland, Oreg	3	30.00	3	27.00	65	2,210.00	2.35	1,997.50	5,004.20

Contract awarded to Robert Smith and executed under date of February 17, 1894.

COMMERCIAL STATISTICS.

The following statement of traffic on the Columbia River, between the mouth of the Willamette River and Cascade Locks, has been compiled from reports of the various steamers and transportation companies doing business on this part of the river during the calendar year 1893:

	Tons.
Grain	5,281
Lumber (2,127,550 feet)	3,191
Cattle	9,168
Sheep and hogs	1,889
Coal	14
Wool	39
Merchandise	26,813
Passengers (159,254)	9,951
Total	56,346

V V 3.

CONSTRUCTION OF CANAL AT THE CASCADES, COLUMBIA RIVER, OREGON.

The Columbia River in making its way through the Cascade Mountain range is forced into a narrow rocky gorge for a distance of 4½ miles. At the head of the gorge the rocks extend entirely across the river, closing the channel completely and causing a fall over them of 24 feet in the low-water stage of the river. This is known as the Cascades. Below this point, throughout the remainder of the distance, the channel was obstructed by bowlders and projecting rocks, and the fall is so great that the river becomes rapids that are navigable at low water. The current in these rapids increases as the river rises until, at the higher stages of the water, it is impracticable for steamers to make headway against them.

The project for improving this locality was adopted in 1877 and modified in 1880, and was again changed slightly in 1886. This contemplates the construction of a canal and lock to overcome the difficulties at the Cascades and the improvement of the river channel through the rapids below to provide a navigable depth of 8 feet at low water. The length of the canal, including the lock, to be 3,000 feet, the length of the lock 462 feet and its width 90 feet, with a lift of 24 feet. The lock was calculated to be available for vessels at all stages of the river up to 20 feet above low water, and the general design of the work permitted, with slight modifications, the passage of boats to a stage of 32 feet above low water, should it be required in the future.

The improvement of the river channel through the rapids has now been completed, and steamers ascend freely to the foot of the Cascades at the lower stages of the river.

Under the authority of Congress contained in the river and harbor act of July 13, 1892, a contract was made and afterwards approved under date of January 24, 1893, with J. G. & I. N. Day for the completion of the canal and lock. This provided that as much of the Government plant as might be required for the prosecution of the work was to be turned over to the contractors, and that the amount appropriated for the work was to be earned within one year from the date of approval of the contract, or within one year from the date of the act appropriating each amount.

Subsequently the sundry civil act of March 3, 1893, provided as follows: "For improving canal at the Cascades of the Columbia River, Oregon, continuing improvement, one million two hundred and thirty-nine thousand six hundred and fifty-three dollars." This act further provided that not more than three-fourths of the appropriation shall be expended during the fiscal year ending June 30, 1894.

The estimate for completing the work made in June, 1892, was $1,745,500, and the act of July 13, 1892, which appropriated $326,250, authorized the entire work to be put under contract and limited the liability to be thus incurred to an additional sum of $1,419,250, or a total of $1,745,500, the amount of the estimate. The sundry civil act of March 3, 1893, as already stated, further appropriated $1,239,653, which, added to the $326,250 before mentioned, gave a total of $1,565,903 available for the work under the contract. The nominal amount covered by the contract is $1,521,625, these figures being based upon the estimated quantities of material required for completing the work. It is highly probable, however, that the actual quantities required will in many cases exceed this estimate, and, as a result, that the liability under the contract will be materially increased and extend to the full amount permitted under the act of July 13, 1892. Should this occur, additional appropriations will be needed to meet this liability and cover the contingent engineering expenses of the work.

During the early part of 1893 the weather proved exceedingly unfavorable for work, and the contractors did not begin laying masonry before the spring rise began. The water soon covered the incomplete walls of the lock, rendering work upon them impossible until the water should subside again and the lock be pumped out. The preliminary work of opening the quarry was commenced in March, and followed by the delivery of stone at the end of May. Stonecutting began early in June, and was continued to the end of the fiscal year.

At the beginning of the present year the lock was still under water, and this condition continued until the latter part of August, when the lock was pumped out. The sediment was then removed, concrete mixers put in order and derricks erected, and finally the work of construction was begun October 12. This was continued until March 31, when the high water of the river again submerged the lock and remained over it until the close of the fiscal year. There has been, therefore, only five and one-half months during the year that construction work has been carried on. This period might have been increased a month or more had the contractors been ready to begin the work as soon as the water subsided in August last.

The provisions of the contract in regard to payments were modified by supplemental articles of agreement, dated August 2 and approved August 16, 1893, to permit the payment of not to exceed three-fourths the contract price for nonperishable material fully prepared to be put in place. The time for earning the sums appropriated for the work was also extended to March 3, 1895, by authority of the Chief of Engineers, January 16, 1894.

The high water mentioned as submerging the work in March finally culminated in June in the highest water ever known in the Columbia River. In 1876 the river reached reference 139.7 on the upper gauge, and, as this was the highest water heretofore known, the top of the completed work was given reference 142 to be above all high waters. This year the river rose to reference 145.7, or 6 feet higher than in 1876, and nearly 4 feet higher than the top of the completed work would have been at reference 142. This remarkable rise shows the necessity of giving the top of the work additional height if it is not to be submerged under similar conditions to those existing this year. The danger from such a submergence readily appears when it is considered that even when the water was at its highest point there was a head of 14 feet of water against the bulkhead closing the upper entrance to the canal. Some damage was done at the lower end of the canal by the violent waves and currents during the high water, and a statement of this, as well as the modifications made necessary by reason of the recent experience, will be the subject of a special report as soon as the water falls sufficiently to ascertain the condition of the entire work.

During the year 2,575 cubic yards of masonry and 15,634 cubic yards of concrete have been laid, and 20,785 cubic yards of rock and 35,267 cubic yards of loose material have been excavated. Work on the steel guard and lock gates has been commenced, and though neither of them has been completed, a considerable portion of most of them has been delivered. Lieut. Edw. Burr, Corps of Engineers, formerly assistant in local charge of the Cascades Canal and lock, and who made the drawings and calculations for these gates, has had supervision of their construction at Sparrows Point, Md., where they are being made.

Lieut. Harry Taylor, Corps of Engineers, has been in local charge of the Cascades Canal during the year, and his report herewith contains many interesting details concerning the work.

This work is in the collection district of Willamette. The nearest port of entry is Portland, Oreg., 65 miles distant by river. The nearest light-house and works of defense are at the mouth of the Columbia River, 156 miles distant.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1876	$90,000	August 11, 1888	$300,000
June 18, 1878	150,000	September 19, 1890	435,000
March 3, 1879	200,000	July 13, 1892	326,250
June 14, 1880	100,000	Sundry civil act, approved March 3, 1893	1,239,653
March 3, 1881	100,000		
August 2, 1882	265,000		
July 5, 1884	150,000	Total	3,443,403
August 5, 1886	187,500		

Money statement.

July 1, 1893, balance unexpended		$1,564,338.33
June 30, 1894, amount expended during fiscal year		330,984.95
July 1, 1894, balance unexpended		1,233,353.38
July 1, 1894, outstanding liabilities	$6,357.87	
July 1, 1894, amount covered by uncompleted contracts	1,202,450.19	
		1,208,808.06
July 1, 1894, balance available		24,545.32

REPORT OF LIEUT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cascade Locks, Oregon, June 30, 1894.

SIR: I have the honor to submit the following report of operations for "Improving Columbia River at the Cascades, Oregon," for the year ending June 30, 1894:

The work during the year has all been done under the terms of the contract, dated December 27, 1892, with Messrs. J. G. & I. N. Day, for the completion of the canal as authorized by act of Congress approved July 13, 1892.

When the contractors assumed charge of the work in February, 1893, the lock pit was full of water and snow covered the ground to a depth of 6 to 8 feet on a level, making active work at that time impracticable. The snow gradually disappeared, but rainy weather during the spring interfered somewhat with work, and no attempt was made to pump out the lock pit or do other work than quarry and cut stone until after the regular summer high water. Stone cutting was begun in June, 1893, and the little stone cut during that month was the only work done under the contract previous to the present year.

At the beginning of the year the regular summer freshet in the river was on, the water was over the lower bulkhead, and the only work in progress was quarrying and cutting stone. The cutting was being carried on with a force of about 50 cutters. The river was falling and went below the top of the lower bulkhead on August 15. Pumping out the pit began August 25. After the pit was pumped out, preparations were made toward cleaning the sediment and débris out of the pit and putting in the masonry in the north lock-chamber wall. One derrick had been set up and was in use lifting the mud and sediment out of the bottom of the pit on September 6, and 3 more were at work by the 27th. September 30 the bed rock under the north lock-chamber wall had been prepared for a length of about 300 feet to receive the concrete. The first concrete was laid October 12, and the first stone October 16. On December 15 a stretch of the north chamber wall about 300 feet in length had been finished to the coping. During October and November work had also been carried on, excavating and preparing the foundations of the upper lock-gate masonry and of the extensions of the lock-chamber walls necessary to complete them, each about 80 feet in length. Laying concrete in the extension of the south wall was begun on January 4, 1894, and in the north wall February 7, and work was continued on this portion of the masonry until the rising river came over the lower bulkhead, March 31, and caused a suspension of all masonry work on the walls. When work was stopped the south wall and abutment had been raised 20 feet and the north wall and abutment 12 feet, out of a total of 46 feet for the walls and of 64 feet for the abutments.

In addition to the masonry work, excavation was carried on during the winter and spring in the canal between the upper lock-gate masonry and the upper bulkhead and on the outside of the upper bulkhead.

The excavation during the year practically completed the excavation in the canal between the upper lock gate and the upper guard gate, partly completed the excavation between the upper guard gate and the upper bulkhead, and made a beginning in the upper entrance. The excavation for the year was distributed as follows: In the lock chamber and at the upper lock gate, 6,940 cubic yards of rock and 7,004.2 cubic yards of loose material; between the upper lock gate and the upper bulkhead, 12,630.5 cubic yards of rock and 6,384 cubic yards of loose materials; and on the outside of the upper bulkhead, 1,214.5 cubic yards of rock and 21,879 cubic yards of loose material.

The physical conditions during the year have been about the average of this locality. During the fall the weather was exceptionally favorable for masonry work, but during the winter more than the average amount of rain fell, although there was very little cold or freezing weather, and in the spring the annual freshet in the river came on nearly a month earlier than usual. Much valuable time was lost during the early fall through lack of proper preparation. Preparation should have been made to begin pumping out the pit as soon as the water fell sufficiently, and for cleaning up the pit and laying concrete as soon as possible after the water was out. Instead of this, pumping was not begun for ten days after the proper time (five days were lost at this time because after everything was ready there were no belts to run the pumps with), and after the water was out nearly a month was lost making preparations which should have been made before, such as overhauling the sand washers and concrete mixers, building trestles, etc., in places where the water had never been. Instead of laying the first concrete October 12, as was actually the case, concrete laying should have been begun not later than September 1. Had the work been begun at the proper time and pushed properly during the winter, both the upper lock-gate masonry and upper guard-gate masonry, on which nothing had been done, would have been sufficiently advanced to have been above the high water during April and could have been completed during the present summer. As it is, nothing more can be done on either piece of masonry until the river goes down in the fall.

The following table gives a summary of the amounts of the different estimates of the work done during the year:

	1893.					
	To July 31.	August.	September.	October.	November.	December.
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Excavation, dry	....	....	1,627	3,140.5	2,659	4,367
Rock excavation, dry	....	....	572	2,033	3,769	2,634
Basalt dimension stone, cut and laid	....	....	....	34	90.19	104.37
Basalt face stone, cut and laid	....	....	....	255.9	527.78	216.94
Granite or basalt stone, laid	....	....	....	98.64	13.89	....
Concrete laid	....	....	....	2,536	4,661	671
Basalt dimension stone, cut	492	283.79	288.03	161.94	74.10	121.63
Basalt face stone, cut	254	229.44	635.08	492.76	498.65	344.62
Granite dimension stone, cut	....	86.12	156.40	61.85	12.79	....
Basalt quarry-face stone, cut	....	....	....	....	....	....

	1894.						Total.
	January.	February.	March.	April.	May.	June.	
	Cu. yds.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
Excavation, dry	5,868	4,808.7	12,747	....	50	....	35,267.2
Rock excavation, dry	3,567	2,165	5,563	482	....	....	20,785
Basalt dimension stone, cut and laid	42.53	84.98	240.92	....	17.93	....	614.92
Basalt face stone, cut and laid	11.08	116.45	246.37	....	....	....	1,374.52
Granite or basalt stone, laid	74.88	169.09	229.05	....	....	....	585.55
Concrete laid	512	2,347	4,632	....	276	....	15,634
Basalt dimension stone, cut	112	221.51	547.29	586.49	273.83	77.81	3,239.92
Basalt face stone cut	151.9	153.93	68.05	11.04	7.36	3.97	2,850.80
Granite dimension stone, cut	121.05	....	....	5.33	12.21	17.25	476
Basalt quarry-face stone, cut	....	....	....	8.32	47.25	131.64	187.21

In addition to the items given in the above table, 3,979 pounds of iron, under the head of "Snubbing hooks," was built into the work and paid for, and 33,920 pounds forged steel, 2,016 pounds wrought iron nuts, 17,621 pounds cast iron, under the head of "Gate anchorages;" 51,517 pounds cast steel, 6,274 pounds steel plates, 2,390 pounds wrought iron, under the head of "Other connections between gates and gate anchorages," and 943 pounds forged steel, 36,600 pounds cast iron, and 932 pounds bronze, under the head of "Valves and frames for culverts," were received.

The last four items in the table and all the iron except the snubbing hooks, were estimated for under the terms of the supplemental contract dated August 2, 1893, which allows payment on "nonperishable material prepared in advance of the time when it may be put in the work."

Cement tests.—The cement used during the year has been the Josson & Co.'s "Neil on Rupell" brand, and North's "Condor" brand. These have been subjected to the usual tests for tensile strength, fineness, time of setting, and swelling. One barrel has been tested in about ten used. The regular tests for tensile strength have been made with neat briquettes broken at the ages of seven days, twenty-eight days, and six months. Tests with sand in the proportion of 1 part cement to 3 parts of sand were also frequently made. Every precaution possible was used to have all briquettes made alike. The cement was always weighed, the water measured, the mixing thoroughly done, and all neat briquettes were moulded with a hydraulic press which gave a uniform pressure on each briquette. The water used in mixing was kept between 60° F. and 70° F. and the briquettes were kept in a room the temperature of which was kept as nearly constant as possible at 70° F. The briquettes were broken on a Riehlé machine and showed the usual variation in strength, some showing nearly twice the strength of others in the same lot made at the same time. The percentage of bad breaks was, however, very small. A break was considered "bad" when the fracture was so far from the center of the briquette that the area of the cross section was 10 per cent or more greater than at the center. This, I believe, was due to the method of molding.

In addition to the regular tests some special tests were made to determine the effect of sifting the cement, both neat and when mixed with sand, to determine the effect of mixing with fine or coarse sand, and for other purposes, and a few tests were also made of different brands of cement, samples of which were furnished for testing purposes.

The results for the year are summarized in the following tables:

TABLE I.

JOSSON & CO.'S.

Month.	Total briquettes made.	Age when broken.					
		7 days.		28 days.		6 months.	
		No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.
1893.							
To July 31	3,255	618	443.2	567	592.1	....	....
August	1,572	412	480.2	52	610.1	....	....
September	1,834	556	472.0	468	596.9	....	....
October	641	340	503.3	676	609.3	....	....
November	958	228	448.4	112	642.4	40	737.8
December	545	112	471.1	288	607.5	214	666.4
1894.							
January	212	20	421.2	94	623.3	....	....
February	470	....	....	....	....	440	717.6
March	722	290	486.4	....	....	654	688.4
April	739	340	540.7	306	647.9	214	728.2
May	557	184	532.6	321	651.8	288	710.1
June	878	146	502.4	314	655.7	16	745.7
Total	12,383	3,246	482.2	3,198	618.4	1,866	702.3

NORTH'S.

Month.	Age when broken.					
	7 days.		28 days.		6 months.	
	No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.
1893.						
To July 31	....	....	....	....	....	....
August	....	....	....	....	....	....
September	20	532.4	20	626.0	....	....
October	....	....	....	....	....	....
November	....	....	....	....	....	....
December	24	399.2	22	560.6	....	....
1894.						
January	....	....	....	....	....	....
February	....	....	....	....	....	....
March	....	....	....	....	....	....
April	....	....	....	....	2	762.0
May	....	....	....	....	10	718.2
June	....	....	....	....	....	....
Total	44	459.8	42	591.8	12	725.5

TABLE II.

[All briquettes made from 1 barrel Josson & Co. cement.]

Age in months.	Briquettes broken.	Tensile strength.		
		Highest.	Lowest.	Average.
1	25	630	396	525.04
2	25	688	442	575.20
3	25	780	476	589.20
4	25	736	342	592
5	25	742	332	596.48
6	25	746	470	623.60
7	25	740	440	612.32
8	25	790	480	689.68
9	25	842	540	701.20
10	25	776	410	649.28
11	22	762	486	622.27
12	25	740	484	641.28

TABLE III.

[Josson & Co. cement.]

Age in days.	Retained on "50" sieve.		Passed "50," retained on "90."		Passed "90" sieve.		Passed "90" sieve mixed with three parts sand.	
	No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.
7	3	297.3	10	261	30	546.9	14	170.1
28	......	....	10	353.4	30	593.1	14	207.0

TABLE IV.

[Josson & Co. cement.]

	Proportions.	Age when broken.					
		1 month.		3 months.		6 months.	
		No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.
Cement in normal state	† N.	25	671.3	25	750.2	25	765.2
Portion retained on "90" sieve	† N.	25	185	25	251.4	25	332.2
	* 1 : 3	24	32.3	24	47.7	23	69.7
Portion passed "90" sieve	* N.	25	653	25	684.5	25	690.1
	* 1 : 3	24	212.5	24	281.8	24	323.3
Portion passed "90" sieve and retained on "175" sieve	† 1 : 3	6	94	......	....	6	156.3
Portion passed "175" sieve	† 1 : 3	10	275.4	10	334.4	10	395.6
Portion retained on "90" then ground and and passed "90" sieve	† 1 : 3	10	171.6	10	233	......	....
Cement in normal state A.	‡ 1 : 3	10	258	10	377	......	....
Cement in normal state B.	‡ 1 : 3	10	236	10	320	......	....
Cement in normal state C.	‡ 1 : 3	10	246.8	10	308.8	......	....

* Cement sample 1.
† Cement sample 2.
‡ Cement sample 3.
A. The sand in these briquettes passed the "10" sieve and was retained on the "20" sieve.
B. Sand passed "20" and retained on "50" sieve.
C. Sand passed "20" sieve only.

TABLE V

[Samples K. B. & S., but of different grindings.]

	Per cent retained on—	Sieve.	Proportion.	Age when broken.							
				3 days.		7 days.		1 month.		3 months.	
				No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.
A	.069 5.46	20 50	N.	8	467.5	8	578	8	674.8	8	712
	15.05	90	1:3	......	....	10	98	10	152.2	10	212.8
B	0 1.49	20 50	N.	9	327.9	9	432.2	9	633.6	9	650.4
	18.73	90	1:3	......	....	10	89.2	10	142.8	10	181.4
C	0 7.68	20 50	N.	10	297.2	10	482.8	10	684.5	10	769.0
	17.19	90	1:3	......	....	10	103.4	10	157.6	10	229.6
D	0.46 9.72	20 50	N.	9	236.0	9	348.4	9	576.7	9	642.9
	17.31	90	1:3	......	....	10	71	8	117.8	10	190.4
E	0 1.34	20 50	N.	10	392.6	10	562.8	10	720.6	10	736.4
	10.10	90	1:3	......	....	10	186.4	10	210.2	10	267
F	1.03 3.55	20 50	N.	10	438.4	10	556	10	646.2	10	718.4
	13.49	90	1:3	......	....	10	159	10	200	10	236.6
B2	0.15 5.36	20 50	N.	......	....	......	....	......	....	......	....
	13.66	90	1:3	......	....	10	103.6	10	143.8	......	....
S. F. G.	0 .34	20 50	N.	......	....	......	....	......	....	......	....
	12.96	90	1:3	......	....	10	80.2	10	137	......	....

TABLE VI.

Brand.	Per cent retained on—	Sieve.	Proportion.	Age when broken.									
				3 days.		7 days.		1 month.		3 months.		6 months.	
				No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.	No.	Tensile strength.
Gibbs & Co.	.31 9.94	20 50	N.	....	....	50	362.3	50	502.9	....	....	50	561.6
	20.16	90	1:3	....	....	20	70.7	20	97.8	....	....	....	....
Gresham	.12 6.22	20 50	N.	8	471.5	8	505.5	8	589.0	8	673.8	....	....
	15.14	90	1:3	....	....	10	129.8	10	172.4	10	215.8	....	....

In the above tables "N" indicates neat briquettes, and "1:3" 1 part cement to 3 parts sand, the sand used being in all cases, except when specially mentioned, sand which has been passed through the "20" sieve only. The "sand" is the regular sand from the sandpit where the sand for making the concrete is obtained, and is a fine gravel with a little loam mixed with it. All sand used either for testing or for concrete is washed before use. Tests of this "sand" showed that 42.1 per cent failed to pass the "10" sieve, 25.1 per cent to pass the "20," leaving the remainder, or 32.8 per cent, to pass the "20" sieve.

Fineness tests of the Josson cement showed that an average of 2.32 per cent failed to pass the "50" sieve, and 17.74 per cent failed to pass the "90" sieve. This means that out of 1,000 grs. 23.2 were retained on the "50" sieve, and an additional amount of 177.4 grs. were retained on the "90" sieve, or a total of 200.6 grs. failed to pass the "90" sieve. In the same way in sample "D," K. B. & S., 4.6 grs. out of 1,000 grs. were retained on the "20" sieve, 97.2 grs. additional on the "50," and 173.1 more on the "90," so that the total which failed to pass the "90" would be 274.9 grs. Of the North cement, 1.21 per cent failed to pass the "50," and an additional 12.88 per cent the "90" sieve.

Both the Josson and the North cements are extremely slow setting. The Gresham set very quickly. The other brands and samples were moderately slow.

None of the cements tested developed any perceptible tendency to swell or blow when made into thin pats.

All briquettes are kept one day in air and the remainder of the time in water.

Steel work.—The contractors are having the gates and other steel work built by the Maryland Steel Company, at Sparrows Point, Md. The material thus far received includes the anchorages for the upper lock and guard gates, the trunnion blocks for the main culvert valves, and part of the wall brackets for carrying the meeting-face plates on the wall. I visited Sparrows Point June 6, and saw both leaves of the lower guard gate nearly ready to ship. Good progress had been made on all the other gates, valves, and other parts to be manufactured there. It was anticipated that all gates, etc., would be shipped during the coming fall.

On June 6, 1894, the water reached a stage at the head of the canal of 145.7 which is 6 feet higher than the high water of 1876, the highest of which there is any record heretofore, and with reference to which the levels of the top of the different parts of the work have been fixed.

The revetted slope walls, where finished, have been built, reference (142) at the upper or east end of the canal and on the north or river side of the canal to reference (130) near the lower or west end. The top of the upper bulkhead was at about (142). As the river rose this was raised and kept above the water level, thus preventing the river breaking through and doing great damage to the work already finished as there was imminent danger of its doing for several days. At the lower end of the canal the water poured over the protection wall on the north side and finally tore down the lower end for a distance of about 350 feet. From 16 to 18 feet of the top of the wall is entirely gone, but how much or how badly the lower portion is damaged, if at all, can not be told until the river falls more than it has to date, as it is still running over the broken portion. On the south side of the canal about 300 feet of the revetted slope was completely torn out, or damaged so badly it will have to be torn down, by the heavy waves and powerful current striking directly against it after the north wall was carried away. Nearly opposite the upper lock gate a stream of water came through into the canal and took out a small piece of the revetted slope. The water ran between the point of rock outside the canal, known as "Powder House" point, and the made ground on the river side of the canal, completely carrying away the earth fill near the point and to within 90 feet of the top of the slope of the canal wall. At one place there is a strip of the fill only 70 feet wide left between the canal and the river. Farther down, opposite the middle of the canal, where the fill was about 350 feet wide, the tremendous current carried away a strip 120 feet wide in spite of great efforts to save it, and I believe was only prevented from carrying away the whole fill by a pile of stone spalls which the contractors had thrown out of their stone sheds.

The unprecedented high water of this summer and the damage it did, and still more the far greater damage so narrowly escaped, show a necessity for making some changes in the heights of the walls of the canal, for giving the revetment a greater resisting power, and for protecting the outer slope of the fill on the river side of the canal from the wash of the waves. These changes need not, however, be of such a character or extent as to delay the opening of the canal a day.

The contractors have been furnished detailed plans of all the masonry work of the lock gates and upper guard-gate masonry, including stonecutters' diagrams of all dimension stones, detailed shop drawings of the gates, main culvert valves, gate engines, valve engines, and all accessories outside the power house. Plans of an accumulator are also nearly finished.

The State portage railroad continued in operation during such parts of the year as the boats running in connection with it could reach the landing places. From July 1 to December 7, 1893, the boats made one trip a day each way. From December 8, 1893, to April 2, 1894, they made a trip up one day and down the next, as one trip a day each way from April 3 to May 16, when they began transferring from below Sheridan Point, about 2 miles down, on account of the difficulty of rounding the point during the high water. On July 1, 1893, the river was 35.4 and on May 16, 1894, was 34.8 feet above low water on gauge No. 2. The high water of the present month carried away the lower incline of the portage road and otherwise badly damaged it.

The following table gives a summary of the meteorological and gauge record for the year:

Month.	Rainfall.	Days on which rain or snow fell.	Average temperature, at 12 M.	Highest readings of gauges.		Lowest readings of gauges.	
				Head of canal.	Foot of canal.	Head of canal.	Foot of canal.
1893.							
July	0.15	3	71.7	121.1	107.4	115.3	100.3
August	0.16	2	75.4	114.6	99.8	105.1	85.8
September	0.16	13	63.0	104.9	85.4	100.6	78.8
October	5.03	15	53.5	103.0	82.4	99.9	77.7
November	15.70	17	47.5	104.3	84.5	100.0	77.8
December	13.37	24	44.8	107.2	89.0	101.0	79.6

Month.	Rainfall.	Days on which rain or snow fell.	Average temperature, at 12 M.	Highest readings of gauges.		Lowest readings of gauges.	
				Head of canal.	Foot of canal.	Head of canal.	Foot of canal.
1894.							
January	21.80	29	40.0	107.1	89.3	99.5	77.3
February	10.70	20	38.3	102.3	81.8	98.3	75.4
March	16.52	22	48.3	111.2	95.1	99.8	77.8
April	7.76	18	57.4	120.3	106.6	110.0	95.2
May	2.31	7	63.7	140.8	126.7	115.9	101.8
June	2.73	11	65.0	145.7	131.7	128.8	114.6
Total	106.39	181	55.8				

Highest reading at head of canal during the year	145.7
Highest reading at foot of canal during the year	131.7
Lowest reading at head of canal during the year	98.3
Lowest reading at foot of canal during the year	75.4

NOTE.—Reading of adopted low water at head of canal is 96, reading of adopted low water at foot of canal is 72.

A tracing showing the details of the hydraulic briquette molding press is transmitted herewith.

Very respectfully, your obedient servant,

HARRY TAYLOR,
First Lieut., Corps of Engineers.

Maj. JAMES C. POST,
Corps of Engineers, U. S. A.

V V 4.

IMPROVEMENT OF COLUMBIA AND LOWER WILLAMETTE RIVERS BELOW PORTLAND, OREGON.

The present project, adopted in 1891, for the improvement of these rivers from Portland to the sea, which includes 12 miles of the Willamette River and 98 miles of the Columbia River, contemplates securing and maintaining a navigable channel having a low-water depth of 25 feet. The original project, that of 1877, which was somewhat modified, had for its object a channel 20 feet in depth. The original depth in the shoalest places was from 10 to 15 feet at low water, and previous to the adoption of this project the money appropriated and allotted was expended in dredging these shoals.

The project of 1877 included contraction works or dikes, bank revetment, closing sloughs, and auxiliary channels or chutes, as well as dredging. Under this project works were constructed in the Willamette River at Swan Island Chute, Willamette Slough, along the left bank of the river to the Columbia River, and also at other sloughs and channels at the junction of the Willamette and Columbia rivers. Works were placed in the Columbia River at St. Helens, Burke Slough, and Martin Slough. The results of these works, aided by the dredging had in 1891, attained a depth of 19 feet.

The present project proposes by the erection of other dikes and dredging to gain an additional depth of 6 feet, or 25 feet at low water. Dikes have been built at St. Johns and Post Office Bar in the Willamette River and at Walkers Island and Cathlamet Bay, or Snag Island, in the Columbia River. The dike at St. Helens has also been extended, and a dike has been built at Martin Island Bar. At the last two places mentioned the work has been done by the United States. At the others the Port of Portland, in furtherance of the approved project, constructed the works at its expense.

The total amount appropriated by the United States for this improvement is $1,030,365. Of this sum $221,780.46 was expended prior to adoption of the project of 1877. Under this project, which was extended in 1891, the net expenditure has been $803,210.59, leaving a balance of $5,373.95 to the credit of the work.

The following extract taken from the report of the Chamber of Commerce of Portland for 1893 gives an itemized statement of the dikes constructed and the dredging done upon the river by the Port of Portland to the close of 1893, and the cost together with the location of the work:

> "The Port of Portland" was organized a municipal corporation by act of the legislative assembly of the State of Oregon in February, 1891, its object being to provide and maintain a ship channel of at least 25 feet in depth, in the Willamette and Columbia rivers, between the city of Portland and the Pacific Ocean; the work to be conducted in harmony with and auxiliary to that prosecuted by the Government of the United States having the same object in view.
>
> The work done under the auspices and with funds available for the uses of the commission to the close of 1893 has been as stated below:

DIKE CONSTRUCTION.

	Linear feet.	Cost of dikes.
At St. Johns, Willamette River	4,000	$34,445.80
At Post Office Bar, Willamette River	6,300	48,362.99
At Walkers Island, Columbia River	13,000	115,700.50
At Snag Island, Columbia River	19,700	160,380.51
Engineering expenses	....	9,181.19
Total for dikes	43,000	368,070.99

DREDGING OPERATIONS.

In the Willamette River—	Cubic yards dredged.
At and above Swan Island	94,701
At Post Office Bar	40,205
	134,906
In the Columbia River—	
At mouth of the Willamette	5,355
At St. Helens	32,630
At Martins Island	23,935
At Walkers Island	24,650
At Cathlamet Bay	33,939
	120,509
Total dredging	255,415

Total cost of dredging, including repairs of dredger	$38,263.24
Total cost of dikes	368,070.99
Paid for interest on bonds and temporary loans	22,214.51
Paid for general expenses, including attorneys, etc	3,215.28
Total expenditures	431,764.02

This work was done under the authority of the Secretary of War with the express understanding—

> That the expenditure of the funds of the Port of Portland shall not be made by the Government engineer, neither shall he exercise authority over said works or their execution, and that the United States shall not incur any liability on account of said works; and provided further, that the officers of said Port of Portland shall permit the officers of the Corps of Engineers, War Department, in charge of work on the Willamette and Columbia rivers, to examine the work done, to see that the whole is carried on in accordance with the approved Government plans. And, further, it shall be distinctly understood that the War Department does not counsel, advise, or encourage the expenditure proposed by the Port of Portland.

WORK DONE DURING THE FISCAL YEAR ENDING JUNE 30, 1894.

The operations during the last year were confined to dredging to aid in establishing the channels that it is proposed in the project to maintain by the various works that have been constructed, and also to provide for the immediate requirements of navigation to the degree necessary in advance of the formation of the new channels contemplated.

At the beginning of the year the hydraulic dredge *William S. Ladd* was employed upon the shoal opposite Tongue Point, which deep-draft vessels had difficulty in crossing. She was then transferred to the proposed new channel at Snag Island, on the Columbia River; afterwards to the mouth of the Willamette River, which was dredged to the depth of 23 feet at low water, to Post-Office Bar on the Willamette; to the shoals at Pillar Rock in the Columbia River, which were also dredged to 23 feet at low water; and back again to the new channel at Snag Island. About the middle of March, the appropriation for this improvement being nearly exhausted, the dredge was laid up.

The following table gives the amount of material removed at each of the places named:

Dredging Columbia and Lower Willamette rivers for year ending June 30, 1894.

Month.	Willamette River.		Columbia River.			Total.
	Post-Office Bar.	At month.	Pillar Rock.	Snag Island.	Tongue Point.	
1893.	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*
July	....	....	....	17,650	13,000	30,650
August	....	1,727	....	48,284	....	50,011
September	13,918	16,111	....	....	....	30,029
October	....	....	60,579	....	....	60,579
November	....	....	16,811	38,689	....	55,500
December	....	....	....	47,557	....	47,557
1894.						
January	....	....	....	63,995	....	63,995
February	....	....	....	39,000	....	39,009
March	....	....	....	14,570	....	14,570
Total	13,918	17,838	77,390	269,754	13,000	391,900

It will be observed that this dredge has removed 391,900 cubic yards of material from five different places, which are separated by a distance between the extreme points of 86 miles, during the eight and one-half months she was at work. At the beginning of the year the dredge was still new, and the crew were also unaccustomed to this method of dredging, and the amount of work done during the first month (July) was comparatively small. The cost of operating the dredge for seven months ending with February was $19,627.07, and 346,680 cubic yards of material was removed, making the cost of the dredging about 5⅔ cents per cubic yard. This included all kinds of material encountered, fine sand with silt, which was difficult to retain in the bins, as well as coarse sand that was rapidly loaded. During January 63,995 cubic yards of coarse sand were removed from the new channel at Snag Island at an expense of $2,803, this latter being the average per month of the cost of running the dredge for the seven months, and for this month the material was removed at about 4⅓ cents per cubic yard.

In addition to the work already mentioned the Port of Portland removed 36,746 cubic yards of material from the Swan Island Channel, Willamette River, and 33,933 from the new channel at Snag Island, Cathlamet Bay. These amounts are included in the foregoing extract from the report of the Chamber of Commerce. The total amount expended to the present time by the Port of Portland is, as stated therein, $431,764.02.

Surveys were made in August and September of the Walker Island and Martin Island bars, and the results show a great improvement in the channel over these bars, due no doubt to the dikes that have been constructed at these localities. Some slight repairs due to damage during high water were made to Martin Island Dam.

During September, for the first time, deep-draft vessels were able to pass fully loaded from the docks of Portland to the sea, and the heavy expense of lightering, that has heretofore been necessary, was avoided. This is conclusive proof of the substantial results that have been produced by the river improvements.

The past year has been remarkable for the almost continuous high water that has prevailed in the Willamette and Columbia rivers. The lowest reading of the gauge at the Government moorings at Portland was 1.4 feet above low water, and it recorded this height for two days in November, and the water remained below 3 feet above low water for but five days in that month. During the last two weeks of September and the first five days of October the water varied between 1.9 and 2.8 feet above low water, and was the longest period of low readings during the year. Gauge No. 2 at the Cascades, Columbia River, has not recorded less than 3.4 feet above low water, and the water remained below 4 feet above low water only three days during the year. There appears to have been a succession of rises in the waters of both rivers, covering the entire year, preventing the usual low-water season. This has been caused by the unusual amount of rain and snow that has fallen during the year upon the area drained by these rivers, especially that of the Columbia. The melting of the accummulated snow and the effect of these rains finally culminated in the most extraordinary rise ever known. On June 7 the gauge at the Government moorings recorded the unprecedented height of 33.11 feet. The highest reading upon the same gauge of any previous high water was in 1890, 28.4 feet. The continued high water has rendered it impossible to make an intended examination of the localities improved, to ascertain the degree to which the desired depth had been attained at the close of the fiscal year.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

The original estimate for procuring a 25-foot channel was $772,464. Of this sum $150,000 has been appropriated by the United States and $406,334 has been contributed by the Port of Portland, leaving $216,130 yet to be appropriated, all of which sum can be profitably expended during the fiscal year ending June 30, 1896.

The accomplishment of this improvement is of the greatest importance to the entire northwestern section of the country, the inhabitants of which find the natural outlet for their productions through the valley of the Columbia. To Portland in her position as the converging center of this immense territory and the head of the proposed deep-water navigation, which she has contributed so largely to secure, it possesses vital interest. These facts establish the great value of the improvement, and especially commend it as worthy of liberal consideration by the Government.

This work is in the collection districts of Willamette and Oregon. The ports of entry are Portland and Astoria, Oreg. The nearest light-house and works of defense are at the mouth of the Columbia River.

APPROPRIATIONS.

Act of—		
June 23, 1866 (Lower Willamette)	$15,000	
March 2, 1867	30,000	
July 25, 1868 (allotted)	21,000	
April 10, 1869 (allotted)	13,365	
July 11, 1870	31,000	
June 10, 1872	50,000	
		$160.365
March 3, 1873 (Lower Willamette, from Portland to the sea)	20,000	
June 23, 1874	20,000	
March 3, 1875	20,000	
Auguut 14, 1876	20,000	
June 18, 1878	30,000	
March 3, 1879	45,000	
		155,000
June 14, 1880 (Lower Willamette and Columbia from Portland to the sea, including bar at the mouth of the Columbia)	45,000	
March 3, 1881	45,000	
August 2, 1882	100,000	
		190,000
July 5, 1884 (Columbia and Lower Willamette, below Portland, Oreg.)	100,000	
August 5, 1886	75,000	
		175,000
August 11, 1888 (Columbia and Lower Willamette rivers, below Portland)	100,000	
September 19, 1890	100,000	
July 13, 1892	150,000	
		350,000
Total		1,030,365

Money statement.

July 1, 1893, balance unexpended	$42,827.42
June 30, 1894, amount expended during fiscal year	38,073.29
July 1, 1894, balance unexpended	4,754.13
July 1, 1894, outstanding liabilities	28.80
July 1, 1894, balance available	4,725.33
Amount (estimated) required for completion of existing project	216,130.00
Amount that can be profitably expended in fiscal year ending June 30, 1896	216,130.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The following statement of traffic on the Columbia and Lower Willamette rivers has been compiled from reports of the various steamers and transportation companies doing business on these rivers during the calendar year 1893. It does not include tonnage carried in deep-sea vessels:

	Tons.		Tons.
Passengers (1,740,386)	109,881	Wool	1,783
Grain	89,862	Merchandise	627,902
Lumber (124,502,531 feet)	186,754	Shingles	5,000
Live stock	3,273	Logs (11,170,446 feet)	285,426
Sheep and hogs	389		
Coal	596	Total	1,310,866

List of steamers plying on the Upper Willamette, Lower Willamette, Columbia, and Cowlitz rivers, Oregon and Washington, during the calendar year 1893.

Name of vessel.	Tons.	Depth.		Name of vessel.	Tons.	Depth.	
		Ft.	*in.*			*Ft.*	*in.*
Augusta	40.90	7	0	Lurline	338.38	6	0
Albina	85.26	4	8	Lena	23.72	0	10
Alliance	213.52	12	0	Maid of Oregon	91.88	5	9
Alice V	41.28	4	0	Maria	184.58	3	0
Argonaut	20.35	10	0	Milwaukee	29.70	2	0
Astoria	76.16	12	5	Messenger	54.53	3	0
Astorian	234.24	2	6	Mascot	199.46	3	0
Altona	189.68	2	3	Mayflower	23.90	6	0
Alarm	16.08	5	0	Modoc	337.55	5	0
Bailey Gatzert	444.32	8	0	No Wonder	235.30	3	0
Brazee	4.99	....		Northwest	301.98	1	3
Brisk	1.05	....		N. S. Bentley	401.42	1	6
Bandoville	99.36	11	0	Ocean Wave	507.34	9	0
Bismark	250.00	4	0	Occident	2.95	6	4
C. M. Belshaw	14.20	5	8	Oswego	21.43	3	6
City of Frankfort	133.47	7	0	Ocklahama	394.19	6	0
C. W. Rich	17.07	5	2	O. K	47.76	4	6
Carrie F	10.64	4	0	Oregon	1,612.28	20	0
Chilkat	106.45	7	5	Orient	429.76	5	0
Columbia	70.41	11	3	Polar Bear	28.80	6	4
Do	1,746.14	20	0	Queen	23.75	6	2
Cygnet	2.86	....		Quinnat	4.20	....	
Cyclone	19.06	5	6	Restless	18.75	5	2
Dispatch	13.47	....		Rowena	4.50	....	
D. S. Baker	566.22	5	0	R. Miler	41.39	6	2
Dalles City	296.38	7	0	R. P. Elmore	42.76	8	0
Dolphin	60.36	8	7	Romona	114.14	5	0
Electric	16.51	4	7	R. R. Thompson	912.06	10	6
Enterprise	137.41	8	3	Regulator	334.38	6	5
E. L. Dwyer	24.44	5	9	Sophia	4.00	....	
Escort No. 2	72.92	12	0	State of California	1,260.06	24	4
Emma Hayward	456.57	7	5	Sea Foam	4.95	....	
Edith	37.01	7	6	Sakana	3.84	....	
Elwood	420.54	7	0	Sarah Dixon	278.84	6	5
Egalite	82.38	4	0	Salem	240.08	1	8
Eclipse	25.03	5	2	Stark Stree Ferry	299.36	2	10
Eugene	350.84	....		S. G. Reed	607.28	8	0
Fannie	276.41	5	0	Telephone	443.24	4	0
George W. Shaver	276.15	2	4	Tacoma	1,311.81	11	7
Gov. Newell	134.43	1	6	T. J. Potter	589.60	9	0
Hassalo	129.58	6	0	Toledo	206.72	1	5
Hattie	2.92	....		Three Sisters	327.33	1	1
Haytien Republic	770.53	20	7	Toiwo	6.27	4	0
Hustler	129.58	7	0	Undine	280.48	3	0
Hattie Bell	129.49	4	5	Vancouver	157.14	....	
Harvest Queen	697.04	6	0	Victorian	809.17	....	
Harvest Moon	56.15	1	6	Vulcan	219.72	4	0
Iralda	36.84	6	0	Wallowa	92.05	11	6
Ione	213.40	2	0	Willamette Chief	523.92	6	0
Ilwaco	62.03	6	0	W. H. Harrison	52.86	6	8
Inland Star	21.87	....		Waterwitch	5.50	....	
Irma	6.15	....		Wm. M. Hoag	431.13	1	6
Joseph Kellogg	272.12	2	2	Wenatchie	....	....	
James B. Stephens	26.40	5	4	Western Queen	74.72	6	2
J. Ordway	194.74	4	0	Wauna	3.10	....	
Kehani	85.41	4	0	Wenona	34.67	6	4
La Camas	9.66	4	0	Young America	42.10	4	5
Louise Vaughn	21.64	6	0				

V V 5.

IMPROVEMENT OF WILLAMETTE RIVER ABOVE PORTLAND, OREGON.

The project for this improvement was adopted in 1878. It consists of the removal of snags and other obstructions and the contraction of the river in wide places, with the object of securing a navigable channel for light-draft boats from Portland to Eugene City, Oreg., a distance of 172 miles. When the work was commenced the mouth of the Yamhill River, 40 miles above Portland, was the head of low-water navigation, with a draft of 2½ feet; only a draft of 1 foot could be carried above, and the channel was greatly obstructed by snags, gravel bars, etc. During recent low waters boats drawing 15 inches could ascend as far as Albany, 100 miles.

The total amount appropriated since the adoption of the project is $151,000, exclusive of the $3,000 allotted from the appropriation of July 13, 1892, to the Yamhill River.

WORK DONE DURING THE PAST YEAR.

At the beginning of the year the snagboat *Corvallis* was between Eugene City and Corvallis engaged in removing snags, etc., and was moving down the river as the work progressed. This work was continued, and, in addition, several wing dams or dikes were constructed to contract the low-water channel and enable boats to pass over the shoal places. The first dike constructed was between Corvallis and Salem, at Luckiamute Bar, and was built from the left bank with an inclination downstream a length of 800 feet. It was given a base of 16 feet, with a height of 5 feet above low water, and was constructed with piles, brush, gravel in sacks, and loose gravel. Depth over bar when dike was commenced was 30 inches and depth on completion was 28 inches, the water in the meantime having fallen 18 inches in the river.

Upon the completion of this dike snagging operations were resumed, and the snag boat worked downstream to Matheneys Bar, below Salem, where a dike of similar construction was built. This dike extended from the right bank into the river a distance of 362 feet. It was 16 feet wide at the base and extended to 4½ feet above low water. The depth of water over the bar when work commenced was 16 inches, and when the dike was completed was 32 inches, the river having risen in the meantime 6 inches.

Upon the completion of the work the snag boat was transferred to the Columbia River for a few weeks. The last of September work was resumed upon the Willamette, and the construction of a dike at Weston Bar was commenced. This work was soon interrupted by a rise in the river, and the snag boat then continued the removal of snags. A few weeks later, when the water had fallen sufficiently, an attempt was made to resume work upon this dike, but another rise occurred and this has been followed by others, and the water at no time during the remainder of the year has been sufficiently low for the dike to be completed. Snagging operations were continued on the river until the beginning of April, with the exception of the month of December, when the snag boat was engaged upon the Cowlitz and Yamhill. The snag boat was also upon the Yamhill the greater portion of the month of April, after which she was laid up, the water being too low in the Yamhill, and the appropriation for the Willamette being too nearly exhausted, to warrant keeping her in commission for further work.

During the year there were removed from the Upper Willamette by the snag boat 1,059 snags and from the banks 775 trees and stumps. The water continuing to fall during the month of May, advantage was taken of this favorable opportunity to remove such snags as had become obstructions to navigation. A party of men supplied with a small boat was sent out for this purpose, and 53 snags were taken from the channel and 41 trees cut from the banks during the month. A few additional snags that were seriously obstructing the channel were removed during the latter part of June in the same manner.

YAMHILL RIVER.

The balance ($1,473.78) of the $3,000 allotted for the improvement of Yamhill River has been practically expended in removing snags and other obstructions from the channel. The snag boat *Corvallis* was engaged upon this river from December 17 to 26; again, navigation having become obstructed by land slides, snags, and drift, she was returned in April and operated until the water in the river became too low for the work to be continued. The party of men removing snags from the Willamette were transferred to the Yamhill June 1, and completed the reopening of the river to McMinnville.

The snag boat removed 201 snags from the channel and 171 trees and stumps from the banks. The party operating with a small boat removed 35 snags from the channel and 72 trees and stumps from the banks.

There remained unexpended at the end of the year a balance of $92.35 of the $3,000 allotted to this river.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1896.

Heretofore the greater portion of the appropriation has been expended in clearing the river of obstructions, which are renewed each high water, and but little progress has been made in the part of the project intended to be permanent; that is, the construction of the wing dams or dikes. As there are a number of places upon the Upper Willamette where such works are required, it would greatly expedite the beneficial results it is expected to obtain for navigation if appropriations were made of sufficient size to permit the dikes to be built at an early date.

With this end in view, and also considering the economical prosecution of the work, it is considered that $60,000 can be profitably expended upon this improvement during the fiscal year ending June 30, 1896. Of this sum $3,000 might be economically expended in removing obstructions in the Yamhill River.

This river is in the collection district of Willamette. The ports of entry are Portland and Astoria, Oregon. The nearest light-house and works of defense are at the mouth of the Columbia River.

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$16,000	August 2, 1882	$5,000
March 3, 1873	3,000	July 5, 1884	10,000
June 23, 1874	7,500	August 5, 1886	10,000
March 3, 1875	25,000	August 11, 1888	29,000
August 14, 1876	20,000	September 19, 1890	11,000
August 18, 1878	20,000	July 13, 1892	*30,000
March 3, 1879	12,000		
June 14, 1880	12,000		
March 3, 1881	15,000	Total	225,500

Money statement.

July 1, 1893, balance unexpended	$18,951.65
June 30, 1894, amount expended during fiscal year	15,525.40
July 1, 1894, balance unexpended	3,426.25
July 1, 1894, outstanding liabilities	150.22
July 1, 1894, balance available	3,276.03
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	60,000.00

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*Of which $3,000 is to be used in improving Yamhill River.

COMMERCIAL STATISTICS.

The following statement of traffic on the Willamette River above Portland has been compiled from reports of the various steamers and transportation companies doing business on this part of the river during the year ending December 31, 1893:

	Tons.		Tons.
Passengers (148,144)	9, 259	Wool	1, 879
Grain	51, 230	Merchandise	158, 951
Lumber (1,550,350 feet)	23, 254	Coal	217
Live stock	659		
Sheep and hogs	57	Total	245, 506

V V 6.

IMPROVEMENT OF COWLITZ RIVER, WASHINGTON.

The Cowlitz River is a tributary of the Columbia River and flows into it from the north about 64 miles above the mouth of the Columbia. The project for the improvement of this river was adopted in 1882, and contemplated the removal of sand bars, rocks, snags, and other obstructions from the channel for 50 miles above its junction with the Columbia River. The minimum depth to Toledo, 30 miles above the mouth, prior to the commencement of the improvement, was from 12 to 14 inches at low water. The effect of the improvement has been to increase the low-water depth over this portion to 30 inches, and the season of navigation is now increased an additional month each year. To maintain this depth it is necessary after each period of high water to remove the snags and other obstructions that have drifted into the river.

The original estimate for this improvement was $5,000 for the first year and an expenditure of $2,000 each subsequent year. The total amount that has been appropriated is $22,000.

As soon as the snag boat *Corvallis* could be spared from other important work upon which she was engaged, which was early in December last, she was sent to remove the snags, drift, etc., that had come into the channel of the river during the previous high waters. Soon after the arrival of the boat the river began to rise again and by the 17th was too deep for profitable work and she was withdrawn. During the brief time she was engaged, 77 snags were taken out and 71 projecting trees and stumps that either obstructed the channel or were liable to fall into it were removed. The very unusual condition of almost continued high water since the snag boat was withdrawn in December until the present time has made but little additional work necessary during the remainder of the fiscal year. Seven snags have been removed from the channel and 7 from the banks in Toledo bend, 1 snag was taken from the channel, and 2 overhanging trees were cut from the bank near Meikles Landing, and 9 snags were taken from the channel near Pumphreys Landing. These were removed to accommodate the steamers in making their landing, and the work was done by the captain of the principal steamboat running upon the river, who was furnished with the necessary powder from this office.

It is highly probable, after the present exceptionally prolonged period of high water, that when the river falls the channel will be found obstructed with snags, logs, etc., to an unusual degree. The removal of the obstructions heretofore, and the consequent improvement in the navigation of the river, has been of great benefit to the inhabitants of the fertile valley through which it flows. It is also of great importance to them that this improved condition be maintained, and an additional appropriation is therefore recommended.

It is estimated that $3,000 can be profitably expended during the fiscal year ending June 30, 1896, upon the improvement of this river in accordance with the present project.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$2,000	August 11, 1888	$3,000
March 3, 1881	1,000	September 19, 1890	8,000
August 2, 1882	1,000	July 13, 1892	3,000
July 5, 1884	2,000		
August 5, 1886	2,000	Total	22,000

Money statement.

July 1, 1893, balance unexpended	$2,272.76
June 30, 1894, amount expended during fiscal year	652.37
July 1, 1894, balance unexpended	1,620.39
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	3,000.00

COMMERCIAL STATISTICS.

The following statement of traffic on the Cowlitz River has been compiled from reports of the various steamers and transportation companies doing business on this river during the year ending December 31, 1893:

	Tons.		Tons.
Merchandise	28,000	Live stock	1,162
Grain	6,060	Passengers (35,334)	2,208
Shingles (200,000 bundles)	5,000	Sheep and hogs	16
Lumber (1,200,000 feet)	18,000		
Logs (90,000,000 feet)	225,000	Total	285,446

V V 7.

IMPROVEMENT OF YOUNGS AND KLASKUINE RIVERS, OREGON.

Youngs River is one of the southern tributaries of the Columbia and joins this river at Youngs Bay, near its mouth; the Klaskuine empties into Youngs River 6 miles above Youngs Bay. The project contemplated the removal of obstructions in Youngs River for a distance of 7 miles above its mouth, and from the Klaskuine from its mouth to Kamms wharf, a distance of 2 miles.

The estimated cost of this improvement was $1,600, and this sum was appropriated by the river and harbor act of September 19, 1890.

During the fiscal year ending June 30, 1891, the sum of $1,206.79 was expended on this improvement, securing a channel depth of 7 feet at high tide to the limits named. No further appropriation is recommended.

Money statement.

July 1, 1893, balance unexpended	$393.21
June 30, 1894, amount expended during fiscal year	15.68
July 1, 1894, balance unexpended	377.53

V V 8.

GAUGING WATERS OF COLUMBIA RIVER, OREGON AND WASHINGTON.

The object of this gauging is the collection of valuable and important data for use in connection with the river improvements, and also to supply information to those interested in the navigation of the river. Gauges for this purpose have been established and maintained at suitable places along the river.

During the past year the appropriation for this work having been practically exhausted, all the gauges were abandoned, except that at Astoria, Oreg., which is self-registering. This gauge being a necessary adjunct of the work of improvement at the mouth of the river, the expense of its maintenance has been paid out of the appropriation for that work.

As heretofore, the daily readings of the gauge have been publicly exhibited in Astoria for the benefit of commerce. The daily bulletin also stated whether the water on the bar was smooth or rough. The small balance available July 1, 1893, was exhausted upon the Astoria gauge.

It is estimated that $1,000 can be profitably expended on this work in the fiscal year ending June 30, 1896.

APPROPRIATIONS.

Act of—	
August 2, 1882	$500
July 5, 1884	1,000
August 5, 1886	1,000
August 11, 1888	2,500
Total	5,000

Money statement.

July 1, 1893, balance unexpended	$6.32
June 30, 1894, amount expended during fiscal year	6.32
Amount that can be profitably expended in fiscal year ending June 30, 1896 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	1,000.00

V V 9.

REPORT OF BOARD OF ENGINEERS ON PLAN FOR OVERCOMING OR REMOVING OBSTRUCTIONS TO NAVIGATION IN COLUMBIA RIVER BETWEEN THREE MILE RAPIDS AND CELILO FALLS, OREGON AND WASHINGTON.

[Printed in Senate Ex. Doc. No. 7, Fifty-third Congress, first session.]

NEW YORK, *April 12, 1893.*

The Board of Engineers constituted by Special Orders No. 177, July 29, 1892, from the War Department has the honor to report:

The Board was appointed in compliance with the river and harbor act approved July 13, 1892, which authorized the President "to appoint a Board of Engineers, to consist of seven members, of whom three shall be from civil life, whose duty it shall be to thoroughly examine the obstructions to navigation in the Columbia River, in that portion from the navigable waters thereof below Three Mile Rapids to the navigable waters above Celilo Falls, and report as soon as they conveniently can to the Secretary of War such plan for overcoming or removing said obstructions as in their opinion is most feasible and best adapted to the necessities of commerce, together with a statement as to the usefulness of such improvement to navigation, its relation and value to commerce, and the most desirable location therefor, the cost of construction and of the right of way, including the necessary land therefor, being considered. They shall also report the details of such plan, with estimates of its cost."

The Board was directed to meet in San Francisco on or about October 17, 1892.

The Board met, as directed, in San Francisco, on the 17th of October, examined the hydraulic lifting dock of the Union Iron Works on the 18th and 19th, and took train for Portland, Oreg., on the evening of the 19th, arriving on the morning of the 21st. On the following day (October 22) they proceeded to Dalles City, stopping on the way to examine the canal and locks now building by the United States at the "Cascades," and the portage railway built by the State of Oregon to transfer freights, etc., pending the completion of the canal. On the 23d and 24th the obstructions to navigation at Three Mile Rapids, the Dalles, and Celilo Falls were examined, and a conference was had with the principal business men of Dalles City. The Board then went to Wallawalla, in the heart of the wheat district, where a public meeting was held, at which the opinions and wishes of the people were expressed by the leading residents of the place. Returning to Portland by the 26th, maps and plans were examined, persons skilled in the construction of steamboats and in the navigation of the river were consulted, the subjects to be considered were discussed, and the Board adjourned to meet in New York City after the completion of the necessary surveys, the preparation of plans, and the collection of needed information.

Mr. Bogue, member of the Board, was requested to take charge of the surveys and the estimates upon them, and they were made under his direction and supervision.

On the 15th of February, 1893, the Board met in the city of New York. Revised plans of the boat railway and car were submitted, maps and profiles of the surveys were presented and examined, reports of committees received and discussed, estimates were revised, and the different plans suggested were carefully considered. On the 1st of March the Board, having formulated its conclusions, adjourned *sine die.*

The navigation of the Columbia is first interrupted by the "Cascades," 63 miles from Portland and 160 miles from the river's mouth. A short canal with locks is now in process of construction by the United States, which will, when completed, provide fully for all the requirements of navigation. Pending its completion a portage railway, five-eighths of a mile in length, transfers passengers and freights from the river below the Cascades to the unobstructed river above them. From the Cascades to Dalles City, 53 miles by the river, navigation is good at all times. Near Dalles City the numerous obstructions begin upon which this Board is directed to report. In the space of 12 miles we have, first, the Three Mile Rapids, a crooked channel 1,500 feet in length, narrow and much obstructed by rocks and currents; then Five Mile Rapids—the Dalles—where for a mile and a half the river rushes with great velocity between precipitous walls of basalt 150 to 300 feet apart. This great contraction of the river beds acts in high water as a dam, "drowning out" all the rapids and falls above it to the level of the river at Celilo. Next comes the Ten Mile Rapids, a similar gorge, but only half a mile in length. and last of all Celilo, with a sheer fall of 20 feet. In this 12 miles of river the total fall is about 80 feet in low water, and in high stages 60 feet.

From Celilo to Wallula, 115 miles by river, a navigation fairly good exists. Thence to the mouth of Snake River, about 10 miles, navigation is much impeded at low water. From the mouth of Snake to Priests Rapids there is again good water. Priests Rapids cover about 10 miles of river with a fall of about 70 feet and are not navigable for commercial purposes. Until improved, they will form the head of navigation on the Columbia as dependent on the Dalles improvement. From Priests Rapids to the boundary of British Columbia there is a navigation much obstructed by rocks and rapids and too inaccessible to be considered with this improvement.

The Snake River enters the Columbia 125 miles above Celilo. For about 53 miles from its mouth the Snake River is obstructed by numerous rocks and rapids, and is unnavigable during the period of low water, the seasons at which the movement of grain is most active. From Riparia to Lewiston, 77 miles, the river is navigated at all times by steamboats of light draft, which now deliver their freights to the railroad at Riparia, the point of contact. Small steamboats are also running from Huntington into the Seven Devils mining country in connection with the railways, but the navigation is not continuous. During good stages of the river, the Snake may be navigated for 40 miles above Lewiston, Idaho, and the Clearwater, which enters the Snake at Lewiston, for 30 miles, but neither of them can be said to have good navigation during low water. When the Lower Snake is made navigable, it will add 200 miles to the navigation to be affected by any improvement at Celilo and the Dalles.

The first steamboats were placed upon the Columbia above the Dalles in 1858, and from that time until 1880 all freights to and from the "inland empire" were transported by the river. Portage railways were built at the Cascades and from Dalles City to Celilo, the latter 13 miles in length, and by them freights were transferred from boats on the smooth waters above the obstructions to others on the reach below, and inversely for ascending freights.

In 1879 or 1880 the Oregon Railway and Navigation Company acquired the rights and property of the Oregon Steam Navigation Company, and immediately commenced the construction of a continuous line of railway from Portland to the eastern boundary of the State. The portage road from Dalles City to Celilo was absorbed and discontinued, and navigation on the upper river above Celilo ceased. Below the Cascades, the open river permitted private parties to compete with the railway lines.

In 1878 the General Government commenced the construction of the Cascades Canal. In 1890 the people of Oregon, impatient of the delay in the completion of the canal, obtained from their legislature a grant of $60,000 for the construction and operation of a portage railway at the Cascades, to be maintained until the completion of the Government works. This road was completed in 1891 and has permitted the revival of steamboat navigation to Dalles City and extended to that point competitive rates.

In 1875 the Oregon Steam Navigation Company transported over 18,000 tons of freight; in 1877 the "passengers and freight were greatly in excess of last year;" in 1878 the "passengers and freight transported over the portage road at the Cascades were largely in excess of the amount transported last year, and the company added four large steamers." In 1880 there were on this section seven boats, whose aggregate measurement was over 4,600 tons.

The demand for the open navigation of the Columbia River comes from the wheat-growing districts east of the Cascade range. Those portions which would now be affected by the improvements at the Dalles lie chiefly south and east of the Columbia, 115 miles to Wallula, and on both sides of it to Priests Rapids, 83 miles above, with a portion of the rich Wallawalla district. The improvement of the lower section of the Snake will open to the sea 200 miles of navigation through the heart of the wheat lands of the "inland empire." Other large tracts, tributary to it but now considered barren, will doubtless be made productive in the not distant future when water for irrigation is supplied.

The wheat crop of eastern Oregon and Washington probably exceeds 400,000 tons. In 1890 the railways were not able to transport the crop to market within a reasonable time, presumably for want of rolling stock. The acreage of 1891 exceeded that of 1890, and it was feared that the railways would not be able to move the crop before the next one would be harvested. (See "Memorial of the Columbia and Snake Rivers Auxiliary Waterway Association," Wallawalla, February, 1891.)

The quantity of wheat and other cereals received at Portland from the country east of these obstructions in 1891, was nearly 8,000,000 bushels. The total receipts of agricultural products from eastern Oregon and Washington were 271,000 tons. From the information the Board has been able to obtain, it is probable that in 1891 about 15,000,000 bushels of wheat were shipped to the Pacific coast from the country which would be, to a greater or less extent, affected by the removal of these obstructions at the Dalles. Statistics for 1892 have not been available.

The report on the internal commerce of the United States for 1890 estimates that the lands tributary to Tacoma and Portland were capable of producing 2,000,000 tons (more than 65,000,000 bushels) of wheat per year.

These figures merely show the recent production of the country, which is rapidly increasing both in population and in production.

Along the Columbia River the lands now productive are not immediately upon the borders of the stream, and the area which can reach the river is at present limited by the distance it will "pay" to haul the grain in wagons. It is not so upon the Snake; the Wallawalla district on the south and the Palouse country on the north extend almost, if not quite, to the river's bank. There is in the minds of the members of the Board no doubt that the improvement of the lower Snake will follow the removal of the obstruction of the Dalles and the reestablishment of navigation on the upper Columbia.

A number of short railways have been built from the wheat centers to points on the main lines of transportation, and others will doubtless be constructed to the river if the navigation should assume sufficient proportions.

The effect of water competition upon the cost of transportation between Dalles City, the present head of navigation, and Portland, which has been rendered possible within the last two years by the construction of the State portage railway at the Cascades, has been to reduce the rates by rail on general merchandise from 67 cents per 100 pounds to 37 cents, and by water to still lower rates. For instance, wheat, of which 1,500,000 bushels are shipped, pays 11 cents per cental by water against 17 cents by rail; wool, which reaches 6,000,000 pounds, costs 20 to 25 cents per cental by water and 50 cents by rail. The water rates include 40 cents per ton paid to the State of Oregon for the portage at Cascades.

These preliminary remarks may be summed up as follows:

The upper Columbia is navigable 198 miles to the foot of Priests Rapids, except, in extreme low water, 10 miles at the mouth of the Snake.

At low water the lower Snake is unnavigable for 53 miles, the improvment of which and of the rapids below would open about 200 miles additional of the Snake and the Clearwater to continuous navigation.

There is now no commerce to tide water on either stream by reason of the insuperable barriers at Celilo and the Dalles.

The removal or overcoming of these obstructions will open for these rivers an outlet to the sea.

The fertile country within reach of these streams sends most of its product to the Pacific coast.

Free navigation means free competition and a reduction of transportation rates.

The methods of overcoming these obstructions, in a commercial sense, are these:

First, by a portage railway extending from Celilo to a point below the Three Mile Rapids.

This railroad will be comparatively inexpensive and can be quickly built, giving the immediate relief demanded by the wheat-growers of the interior. It does not overcome obstructions in the sense of passing the vessel, but involves transshipment at each end. Its capacity, as determined by experience, is, with hand labor and one incline at each end, 1,600 tons per day, which can be doubled by the duplication of the inclines. It may also be considerably increased at small cost by the use of machinery.

Second, by a boat railway, by which the steamboat or barge would be lifted by hydraulic power from the water on a car with wheels, which, upon arriving at the proper elevation, would be run upon a railway track, hauled by locomotives to the other terminus, and lowered by hydraulic lifts to the water below. The maximum lift at Celilo is 47 feet and at Big Eddy 77 feet.

The Board regards the boat railway as feasible with curvature not exceeding one degree (or a minimum radius of 5,730 feet) and with the modified form of car proposed. It is, however, as yet experimental, and has certain disadvantages as compared with a canal.

The railway and car, as projected, will pass the flat-bottomed boats usually employed on these rivers, when in good condition, weighing, with cargo, up to 600 tons, and not exceeding 168 feet in length by 38 feet in breadth.

The maximum capacity of the system, with the estimated equipment (two cars and four locomotives), is sixteen boats each way per twenty-four hours; with a full equipment, at an additional cost of half to three quarters of a million, the maximum capacity has been estimated at forty boats each way per day.

Third, by a canal. From previous estimates upon partial canals at these points, and from other information, the Board had derived the impression that a continuous canal was inadmissible by reason of its great cost. Under this impression the funds at its disposal were appropriated to surveys and plans for a portage railway and a boat railway, and none remained for the survey of a canal. That nothing should be neglected, however, an estimate was made from such former surveys and other data as were available, supplemented by personal observations upon the ground, the result of which was so favorable as to modify materially the opinions of the Board.

This estimate was necessarily not exact, but the majority of the Board are of opinion that a canal of capacity to pass boats of the dimensions for which the boat railway provides will not greatly exceed $4,000,000. This sum is considerably in excess of the cost of a boat railway, but the cost of operation of a canal will be less, its capacity greater, and its limitations less upon the character and condition of the boats. The width of the proposed canal is 100 feet at bottom and its depth 6 feet. Its length is sensibly the same as that of the boat railway, about 8½ miles, the location like it, on the Oregon side of the river, and the termini the same or nearly so at Celilo and Big Eddy. The lift of the lock at Celilo is at low water 20 feet, raising the boat above all ordinary river floods. At Big Eddy the height above low water is 72 feet, which can most speedily be overcome by a hydraulic lift or elevator, carrying a caisson, in which the boat remains afloat. Intermediate are two locks, with lifts of 15 feet. With greater expenditure of water, time, and attendance, a flight of locks may take the place of the lift at the Big Eddy.

The water supply will be by a feeder 13,000 feet in length from the river Des Chutes.

The drifting sands which occur at the same points on all these lines will be a source of expense in maintenance of either system, as they now are to the Union Pacific Railway, adding a certain sum to the cost of its operation. The high wind generally prevailing in this gorge will also obstruct the movement, affecting particularly the boats on a canal.

Location.—While a portage railway may be aligned with advantage upon the Washington or northern bank of the Columbia, the boat railway, owing to necessary restrictions as to curvature, and also to the fact that its construction would materially interfere with the projects of the Columbia Railway and Navigation Company, now said to be on the point of development, would, if placed on the north bank, involve largely increased expenditure and a doubtful issue. For these reasons it has appeared to the Board expedient to confine its location to the Oregon bank.

Estimate.—The portage railways considered are two in number. They both extend from Celilo to Dalles City, and are both about 12½ miles in length. They have not the same alignment. One is to be built upon the lines and grades of the boat railway from Celilo to Big Eddy, so as to form, with its roadway, a portion of the wider roadbed of the larger work. The cost of this line is $682,301. It requires that the line of the Union Pacific Railroad should be shifted at several places, the cost of which, together with a right of way, is included in the estimate. The sum of $429,705 expended on this line would be directly applicable to the boat railway if subsequently built. The ultimate cost of the portage road and the boat railway when built would be $2,517,063.

The cost of the boat railway alone would be $2,264,467, which includes the sum of $170,000 for the improvement of the channel at Three Mile Rapids.

The other alignment of the portage railway was made without regard to a boat railway and with a view to the least expenditure for construction. It would cost $454,390, of which $156,285 would be applicable to a boat railway from Celilo to Big Eddy.

In all these estimates the sum of $30,000 is included for right of way.

As already stated, the cost of the canal will not, it is believed, exceed $4,000,000.

In considering these projects with a view to selecting the one "best adapted to the necessities of commerce," the Board is embarrassed by the difficuly of forecasting future commerce on the river.

At present there is no commerce on the Columbia above Celilo. It can not be doubted that when the obstructions to navigation near the Dalles shall be removed there will be a commerce, although the extent of its development can not be foreseen.

There is no fuel supply in the wheat districts. Boats on the Snake are now supplied with wood cut 100 miles to the westward and transported to the river by rail. This circumstance, together with the distance of the wheat lands from the river, and the number of rapids in the Columbia, is not favorable to a cheap transportation on the upper river. But whatever may be the extent of the navigation in the future, it may be said that when the great obstructions at the Cascades and the Dalles shall have been overcome, the fact of an unobstructed waterway to the sea will act as a corrective of excessive rates of transportation by rail.

In view of these facts, the Board is of opinion that a portage railway will meet the urgent demands of the wheat district, will supply the present necessities of commerce, and be useful in the construction hereafter of a canal. Believing that the boat railway, although feasible, is as yet experimental and has certain disadvantages as compared with a canal, believing also that a canal can be built within reasonable limits as to cost, the Board respectfully reports:

First. That the obstructions to navigation in the Columbia River from the navigable waters thereof below Three Mile Rapids to the navigable waters above Celilo Falls can be overcome in the most feasible, speedy, and economical manner, and in that best adapted to the present necessities of commerce and to its future development, by the construction of a portage railway, of standard gauge, on the south side of the Columbia River, from Celilo to Dalles City, the cost of which is estimated to be $454,390.

Second. When the necessity shall arise for accommodation greater than can be furnished by a portage railway, this Board recommends that the construction of a canal, located on the Oregon side of the river, be undertaken.

The usefulness of this work to navigation arises from the fact that it opens a free communication from the upper rivers to tide water, a merit common to all methods of overcoming the obstructions about the Dalles.

Its value to commerce consists in permitting a line of transportation by water, upon which competition shall be absolutely free.

The effect of this competition may or may not be to divert large quantities of traffic from the railways to the water lines, but all experience shows that the possible competition will be a great regulator of railway rates, not only at competing points, but by their reaction upon the general transportation rates of the surrounding country.

The question of the right of way was investigated by a special committee of the Board. The surveys having shown that the south bank of the river is in all respects to be preferred to the north bank for the location of a portage railway, a boat railway, or a canal, it became unnecessary to consider the cost of interfering with the location and rights of the Columbia Railway and Navigation Company, which occupies the available ground on the north bank. On the south or Oregon side private owners of property have promised to give the right of way for either improvement, upon being paid for actual damage to buildings, orchards, etc. The more important interference is with the Union Pacific Railway, successor to the Oregon Railway and Navigation Company. The right of way of this company is generally 100 feet in width on each side of its center line, and either improvement must encroach upon it for considerable distances. In addition to the encroachment, either of these projects would also require the track of the railway to be shifted to the south in several places to a greater or less extent, to make room for the proposed construction. These changes would improve, rather than injure, the line and grades of the Union Pacific, and their cost, which would not be great, is included in the estimates of the several projects. Aside from these changes, the cost of right of way for either project is estimated at $30,000, as given above.

The Union Pacific Railway Company, being asked if it would permit the proposed construction to be made upon being paid in full for all necessary alterations of its line or works, declines to make a specific reply until more definite information shall have been furnished. It suggests, however, that if the construction of a railway of ordinary type (a portage railway) is contemplated, its own line should be used in connection with the navigation of the river above and below the points referred to, Celilo and Dalles City.

In the opinion of the Board this suggestion is totally inadmissible.

The suggestion of a dam at the head of the Dalles to pond the water back to the foot of Celilo Falls has been presented to the Board, and has been favorably considered, but the data are not available and can not be obtained at this time to justify its recommendation. The project requires a short canal, with locks at Celilo, and another from the head of the Dalles to Big Eddy, and is not free from objection on the score of interference with water rights and fishing interests. The Board, however, suggests that the necessary surveys be made, so that when an enlarged improvement shall become necessary this plan may receive consideration as an alternative proposition.

Respectfully submitted.

CHAS. R. SUTER,
Lieut. Col. of Engineers.
W. R. KING,
Lieut. Col. of Engineers.
CHAS. J. ALLEN,
Major of Engineers.
WM. R. HUTTON,
Civil Engineer.
VIRGIL G. BOGUE,
Civil Engineer.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., May 29, 1893.

The undersigned recommends a boat railway from Celilo to Big Eddy on the Oregon side of the river. In other respects he concurs in this report, with the qualification that the portage railway therein recommended be aligned and constructed in such manner that it may be, for most of its length, a component part of a boat railway to be subsequently constructed.

The cost of the portage railway from Celilo to Dalles City, as thus built, will be $682,301, of which amount $429,705 will be directly applicable to the boat railway, which will require, in addition, for its completion $1,834,762. The cost of improvement of Three Mile Rapids, estimated to be $170,000, is included in this sum.

Lieut. Edward Burr, Corps of Engineers, secretary of the Board, to whom was assigned the duty of preparing a design for a boat carriage, gives in Appendix 1 a description of the boat railway and appliances as they are recommended.

This method of transferring boats, while nowhere used as here proposed, is feasible, and as projected its capacity is sufficient for anticipated needs of commerce. In cost of construction it comes much less than a canal, and it is well adapted to local conditions existing at the Dalles.

There is a great advantage in constructing the boat railway at this point by parts—with an interval of several years. The track first built, used as a portage road, will serve to develop commerce, now nonexistent, on the upper river. It will thus determine the classes of boats and barges best adapted for profitable service under the peculiar circumstances of navigation there existing. From these data, the dimensions of cars, lifts, and locks required to transport boats become fixed, and the transportation system, when completed, is then proportioned to needed requirements.

For want of better information the boat-railway project has been proportioned for the largest boats used some years ago, when navigation on the upper river existed. But it would unquestionably be the part of prudence to defer construction of lifts and cars until new conditions of production and commerce shall have determined future dimensions of boats, which will probably be larger than they were a few years ago.

The considerations also apply to the locks and lifts of a canal, if this mode of transfer be preferred.

Respectfully submitted.

G. H. Mendell,
Colonel, Corps of Engineers,
President of the Board.

The undersigned concurs in the statements and conclusions of the majority of the Board, except in so far as they hold forth a high-level canal as even probably feasible, at a cost which "will not greatly exceed four million dollars;" and that the maintenance and operation, in this particular location, of such a canal, if built, would upon the whole possess any material advantages over the very much cheaper project of a boat railway. This dissent is based principally upon peculiar local conditions applying here, but which would not apply to ordinary estimates of cost of either building, maintaining, or operating canals elsewhere, even made, as this estimate is, without full surveys.

These peculiar conditions are found in the basaltic cliffs, full of seams and fissures, through which the construction must take place; in the rapidly and everlastingly drifting sands, which may be kept off railway embankments, and quite easily removed from railway cuts, but which, falling in the water of the canal, at times fast enough to fill its bed at places in a day, could only be taken out by dredges and lighters; and also in the violent winds from the Pacific, which almost incessantly sweep through the gap there formed by the river in the mountain wall.

The undersigned is also unwilling to recommend such an indefinite postponement of the extension of unbroken transportation by boat to the large territory, and to the increasing commerce to be benefited by it, as must result from the recommendation of the majority, of a mere portage railroad and additional surveys with a view to a canal in the distant future. Especially and particularly, also, he would point out that, while the right of way may now be secured for a small sum, it will year by year become more difficult to obtain, and very much more expensive. The banks will be more and more thickly occupied with railroad tracks, salmon fisheries, and other improvements. Even the numerous water powers may be utilized for distant transmission by electricity, and ground essential to either a canal or a boat railway be thus occupied by private enterprises which it would be very expensive to remove after they are once established.

As to the project for damming the river at the head of the Dalles, to drown out the obstructions above, the undersigned considers that its destruction of the salmon fisheries and the water powers above, is alone sufficient to eliminate it from further consideration.

This report is accompanied with a complete and carefully studied project for a boat railway, with all appurtenances and equipment, and careful estimates of cost based upon actual survey and location on the ground. (See Appendix No. 1.) The Board unanimously regard it as entirely feasible, and say of it: "The railway and car as projected will pass the flat-bottomed boats usually employed on these rivers, when in good condition, weighing with cargo up to 600 tons, and not exceeding 168 feet in length by 38 feet in breadth."

The Board also unanimously estimate the entire cost of the same as $2,264,467, which includes cost of right of way and damages, and also a desirable improvement of the Three Mile Rapids. Its capacity, at that cost, would be 16 boats each way per day, but capable of expansion at moderate cost to 40 boats each way per day, as set forth in the above report.

The undersigned, believing such results to be at once a satisfactory solution, and the only economical solution of a problem of peculiar and increasing difficulties, now recommends that this project be adopted as the project for final execution.

Meanwhile, also, as its complete construction will require several years, under the ordinary conditions attending such work by the Government, and as even such a partial "overcoming of the obstructions" as can be afforded by a portage railroad will produce beneficial results to commerce more than commensurate with the expense involved, and sufficient for present necessities, the undersigned further recommends that, while the right of way for the full project shall be at once secured and held in possession, only one of the two tracks necessary to the full project shall be constructed at present, and that instead of erecting the hydraulic lifts at Celilo and Big Eddy a portage extension of this track shall be made from Big Eddy to Dalles City, and proper inclines and equipment provided, in order that the line may be utilized speedily as a portage road, and worked as such until the increasing demands of commerce require the completion of the full project. Of course, also, when that time arrives all of the details of this project would have the benefit of whatever advances and improvements the experience of all kindred enterprises elsewhere in the world may meanwhile suggest. The estimated cost of this present construction and equipment here recommended, with right of way for the full project, is shown in the attached exhibits, based on actual location, as $682,301. Of this sum $429,705 would operate to reduce the final cost of the full project, so that its future completion would cost but $1,834,762, a grand total of $2,517,063.

The portage road proper, recommended by the majority of the Board, is estimated to cost $454,390. It provides only present and partial relief, leaving the future to care for itself, and holding out but a vague and uninspiring hope that further surveys may show that "not much more than four millions" may give full relief, if the right of way remains indefinitely as cheap as it is at present.

The recommendation of the undersigned, at an additional present cost of but $227,511, provides exactly the same present relief, takes ample care of the future at a further cost of much less than two millions, and takes no risk of future cost and difficulties in procuring the right of way.

Respectfully submitted.

E. P. ALEXANDER.

SURVEYS AND ESTIMATES.

The surveys and estimates of various lines to be considered were assigned to Mr. V. G. Bogue, C. E., who located two lines for boat railways, one on each side of the river from Celilo Falls to Big Eddy below the Dalles Rapids.

Extensions of these lines were run partly by preliminary survey and partly by location, to obtain information lacking to a good knowledge of the possible portage lines.

The boat-railway lines have maximum curves of one degree, 5,730 feet radius, and maximum grades of 13.2 feet per mile.

The portage lines are four in number.

OREGON SIDE.

Line 1. From Celilo to Dalles City.—Between a point opposite Big Eddy and Celilo it occupies the north side of a proposed boat railway, conforming to its grades and alignments, so that when built it could become a component part of a boat railway.

Line 2. From Celilo to Dalles City.—Between Celilo and Big Eddy its location conforms in part to the line of the proposed boat railway. Between Big Eddy and Dalles City it coincides both in grade and alignment to line 1. This is the least expensive route for a portage road on the Oregon side.

WASHINGTON SHORE.

Line 3. From Three Mile Rapids to a point opposite Celilo.—This line coincides with the location of a boat railway over the portion between Big Eddy and Celilo Falls.

Line 4. Foot of Three Mile Rapids to a point opposite Celilo.—This line is located without reference to use as a part of a boat railway, and simply as a portage road. West of Big Eddy it coincides with line 3. It is the least costly line having a terminus west of Big Eddy.

For reasons stated in the report the Board found it expedient to confine its recommendations to lines on the Oregon shore.

The locations of these lines are shown on the general map.

The estimates for the lines on the Oregon side, as modified by the Board, are here presented.

The buildings are estimated as of wood.

1. Estimate of cost of line 1, Oregon side.—The cost of a single-track portage railway, standard gauge, from Celilo to Dalles City, located and built to be a part of a boat railway from Celilo to Big Eddy, but used for a time as a portage railway with 56-pound rails, 12.59 miles of main line, including right of way and cost of changes in Union Pacific Railway, equipment, buildings, wharf boats, and inclines, 15 per cent for contingencies, complete in every respect for service, is estimated to be $682,301.

Of this amount the sum of $429,705 is applicable to a boat railway.

2. *Estimate of cost of line 2, Oregon side.*—The cost of a single-track, standard gauge railroad from Celilo to Dalles City, on Oregon side, 56-pound rails, 12.44 miles in main line, with equipment, telegraph line, wharf boats at each end, buildings and warehouses, and including necessary changes in Union Pacific line and right of way and 15 per cent for contingencies, complete, ready for operation, is estimated to be $454,390.

This road is located without relation to a boat railway, and is the line recommended in the main report.

3. *Estimate of cost of a boat railway from Celilo to Big Eddy, on Oregon side.*—The cost of a boat railway from Celilo to Big Eddy, on Oregon shore, 8.75 miles in length of main line, 90-pound rails, with lifts at Big Eddy and at Celilo, and two transport cars for boats 168 by 38 feet, right of way and changes in Union Pacific line, telegraph line, buildings and equipment, contingencies 15 per cent, complete and ready for operation, is estimated to be $2,094,467; add cost of improvement of Three Mile Rapids, $170,000; total, $2,264,467.

4. *Estimate for a boat railway, built by parts (the first part being used as a portage) between Celilo and Big Eddy.*—Cost of a boat railway from Celilo to Big Eddy, with location between these points of the portage railway:

Cost of portage road as by estimate	$682, 301
Cost of lifts, additional track and equipment, including 15 per cent contingencies, work ready for operation	1, 664, 762
Cost of improvement of Three Mile Rapids	170, 000
Total	2, 517, 063

APPENDIX 1.

DESCRIPTION OF BOAT RAILWAY AND APPLIANCES.

[By First Lieut. Edward Burr, Corps of Engineers.]

The object of this project is the transfer of boats and barges by rail from above Celilo Falls to below the Dalles Rapids, a distance of about 9 miles, in a rugged country.

The boats are of the ordinary stern-wheel type, with flat-bottomed hulls, molded toward the bow and stern, and rounded at the lower corners of the midship sections, practically strongly built boxes of small height as compared with their length, and of considerable longitudinal flexibility notwithstanding a trussing of "hog-chains." The maximum dimensions assumed for this project are: Length over all, 165 feet; breadth over all, 38 feet; draft, 5 feet; and weight, loaded, 600 tons.

The main points to be considered are the roadbed, the car, and the lifts. They will be taken up in the order in which mentioned.

The roadbed.—The difference in river level between the head of Celilo Falls and the foot of the Dalles Rapids is, at extreme low water, 80.15 feet, and at extreme high water, 41.84 feet. The extreme rise at the two points is 28.29 feet and 66.6 feet, respectively. The plane of reference is 8.01 feet below low water on the gauge at Dalles City. The references of extreme high and extreme low water at the foot of the Dalles Rapids are 75.9 and 9.3, respectively, and at the head of Celilo Falls are 117.74 and 89.45, respectively.

The best location for the roadbed has been found to be on the south or Oregon side of the river, and extends from the pool above Celilo Falls to the elbow below Big Eddy, at the foot of the Dalles Rapids. Owing to the rugged character of the locality, an alignment rectilinear throughout is impracticable. An alignment composed of tangents, with turntables for making the necessary changes of direction, would at points be difficult of construction. An alignment composed of tangents connected by curves of easy curvature is possible at a moderate cost. In the present project the curves are limited to a maximum of 1° (5,730 feet radius).

The length of track between the faces of the lifts is 43,020 feet. A transfer table for passing trains midway between the lifts is provided and turn-outs at each lift for passing locomotives around the cars.

On the accompanying profile is shown the grade line at base of tie. The grade line is level at each lift, the reference being 125 at the Celilo lift and 75 at the Big Eddy lift. The maximum gradients are 0.25 per cent, or 13.2 feet per mile. Different gradients are connected by vertical curves, such that the middle ordinate for a chord of 165 feet shall not exceed a quarter of an inch. The cars and boats have sufficient flexibility to accommodate themselves to this deflection.

The estimates are based upon slopes of 4 on 1 in rock cuts and 2 on 3 in earth cuts and for embankments. Embankments of earth are to be riprapped, and allowance has been made in the estimates for extra work in forming these embankments. Cuttings are estimated with a bottom width of 45 feet and embankments with a top width of 38 feet. Culverts of masonry or of iron pipe are provided where necessary.

The tracks are two in number of the standard 4 foot 8½ inch gauge, placed 20 feet between centers, and without elevation to the outer rails on curves. The ties are of fir timber, 8 inches by 10 inches by 10 feet, 2,992 per mile of single track. Every fifth tie is 30 feet long, and extends across both tracks, to maintain the 20-foot gauge. The rails weigh 90 pounds per yard, and both the rails and their fastenings should be of the most approved pattern at the time of construction. Two feet of broken stone ballast is estimated for.

The roadbed is placed above extreme high water, except for about 12,000 feet at the Big Eddy end, where it is subject to submergence at rare intervals, and the ties should be loaded with a sufficient weight of old rails or other material to maintain them firmly in place.

The car.—It is required of the car that it shall transport with safety the loaded boat or barge and have sufficient flexibility to pass over the horizontal and vertical curves of the above line. The maximum load to be carried is estimated at 600 tons.

The proposed car is composed of a platform of plate girders carried upon a system of 4-wheel trucks. The platform is 166 feet long and 35 feet wide. It is braced for lateral stiffness, and its comparatively small depth gives it a small amount of vertical flexibility. The lateral flexibility, to enable the car to pass around the proposed curves, is obtained by the arrangement of the trucks. There are 34 trucks, placed in two lines of 17 each, the two lines being 20 feet between centers. The trucks in each line are spaced 9 feet and 3 inches between centers for the central 111 feet of the car. At the ends of the car, where the loads are lighter, the intervals between trucks are increased to 10 feet and 11 feet 6 inches. In each line the third truck from each end is supposed to be pivoted and without lateral motion, giving two pairs of trucks 111 feet apart, which serve to guide the car on the rails. The remaining trucks have a freedom of motion laterally, sufficient in amount to permit them to accommodate themselves to the alignment of the track, besides being pivoted in the usual manner. This freedom of motion laterally may be obtained by the use of any of the swing-beam or other lateral-motion trucks used for ordinary railroad rolling stock.

The truck shown on the drawings herewith is modeled after a roller-bearing truck in use on the Northern Pacific Railroad. It is of the ordinary Bogie type, with arch-bar frames. The springs are placed directly upon the truck frames, between the wheels, and upon them rest the roller bearings on which the lateral motion takes place. Each bearing consists of two rollers, 10 inches long and 2½ or 3 inches in diameter, and each roller works in a separate seat or pocket. The form of the seats or pockets may be such as to give any desired ease of motion. As the truck moves off the center, the loading of the springs becomes unequal, and for a motion of 3½ inches this unequal loading causes a slight difference in the compression of the springs on the two sides of the truck, though less than one-eighth of an inch. With symmetrical roller seats this gives a slight inclination to the bolster, but with roller seats as shown the bolster may be kept horizontal, and by the use of plane surfaces properly adjusted as to inclination any desired ease of motion may be obtained, with a nearly constant resistance to motion and tendency to return to the center. The details of the truck may be found on the drawings herewith.

The platform of the car has a length of 166 feet and a width of 35 feet. It is composed of two main longitudinal girders, 20 feet between centers and extending the full length of the car, one over the center of each line of trucks. At all truck points, and at the ends of the car, these girders are connected by transverse girders, which are extended beyond the main girders to the full width of the platform. The ends of the transverse girders are connected by a channel bar, and their centers by a light plate girder. The platform is braced by rods in each rectangle, for lateral stiffness, and carries a set of closely spaced longitudinal timbers for the support of the boat. One set of bilge blocks, so designed as to drop below the top of the platform and not obstruct the free entrance of the boat over the car, should be placed at each end of the platform. Drawbars are placed in each end of the main longitudinal girders for attaching the locomotives. If considered necessary, arrangements can be readily added by which the equalized traction of the locomotives can be applied to the center of the car. Reference is made to the drawings herewith for all details of construction.

Owing to the short time allotted for the preparation of the drawings, many of the details of the car, such as the journals and journal boxes, wheels, springs, etc., have not received the amount of consideration necessary before definitely deciding upon the best form for them. Their final consideration should be left to the engineer in charge of the project at the time of its construction. On account of this incompleteness of details, it is not possible to give an accurate estimate of the weight of the car, but it will not vary from 300 tons by more than a few per cent.

With a car weighing 300 tons, and a load of 600 tons, the total weight becomes 900 tons. Uniformly distributed between 136 wheels and over 158 feet 9 inches of double track, the load becomes 6.6 tons per wheel, and 2.8 tons per foot of single track. It is not assumed, however, that the load is uniformly distributed, but that it is greater at the center of the car than at the ends, with resulting loads of 7.2 tons per wheel, and 3.1 tons per foot of single track. These loads are practicable and within the limits of current railroad practice. They are less than have been proposed for other projects of a similar character. Provision has been made in the design of the details of the car for the derailment of one truck and the carrying of its load by the two adjoining trucks on the same line of rails with an increase of the wheel loads of those trucks to 10 tons per wheel. This is, however, an emergency condition, and the maximum of 10 tons per wheel would not be attained, since other trucks than the two adjoining ones on the same line of track would carry part of the load of the derailed truck.

For one-degree curves of 5,730 feet radius and a pivotal distance of 111 feet the maximum deflection of the center trucks will be 3¼ inches, and of the end trucks will be 3 inches, diminishing toward the pivots. These maximum deflections will be diminished appreciably by the play that is usually found in the journal boxes and by making the gauge of the wheels one-half inch or more short of the gauge of the track, as is done on some locomotives. The increase in load on the wheels, due to the shifting of the load from the center of the truck, will not be more than 0.7 ton per wheel.

The roller-bearing truck described herewith is recommended as being better adapted for the present purposes than the swing beam or other forms of lateral-motion trucks in current use. With it the desired lateral motion can be had with any reasonable ease of motion and with less resistance than with many of the swing-beam trucks in use. It has given satisfaction in actual service, and being simpler of construction and having fewer parts, it is less subject to breakages and will cost less for repairs.

The lifts.—A lift is required at each end of the roadway, with a capacity to raise a live load of 900 tons. With a draft of boat of 5 feet and a height of car of 5 feet at extreme low water, the height to be lifted will be 47 feet at the Celilo lift and 77 feet at the Big Eddy lift. Vertical hydraulic lifts are proposed, and the hydraulic ship-lift now in successful operation at the shipyards of the Union Iron Works, in San Francisco, Cal., has been used as a model, such modifications being made as were called for by the differences in locality, load, and height of lift, or as were suggested by the operation of that lift. Full detail drawings of the Big Eddy lift were forwarded with the report of November 27, 1889, of the Board of Engineers appointed by Special Orders No. 38, Headquarters, Corps of Engineers, series of 1888, and printed in Ex. Doc. No. 64, House of Representatives, Fifty-first Congress, first session. Reference is made to these drawings for the details of this lift.

The proposed lift consists of a platform, or cradle, supported by chains from the heads of a series of hydraulic rams placed in two rows, one on each side of the platform. The chains are so arranged over sheaves as to give the platform a speed and movement four times that of the rams. A device for regulating the admission of the water to each press so controls the movement of the rams as to maintain them at a uniform speed and the platform in a horizontal position, notwithstanding any differences in the loads on the several rams. The presses and rams are inclosed in a riveted framework, which serves to steady the presses, to guide the rams and the platform when in motion, to carry the regulating mechanism, and to support the platform at the level of the tracks.

In the Union Iron Works ship-lift, the platform is suspended from each ram by 8 steel wire cables, and the stroke of the rams is multiplied by two. In the shops of the company is a single-cylinder, hydraulic overhead crane, with a lifting capacity of 50 tons, the stroke of the ram being multiplied by four. A similar construction should therefore be practicable for a load per ram one-half more. The details of the proposed lifts are as follows:

There are 16 rams, placed in two rows, 45 feet 11 inches between centers of rams. The rams in each row are 22 feet 6 inches between centers. The press cylinders are

31.5 inches interior diameter, with a 5-inch thickness of metal, and are cast in one piece. Each rests upon a base-casting weighing 13.1 tons, which also carries two of the chain sheaves and supports the vertical posts of the framework. To the top of the press cylinder is bolted, by external flanges, a guide cylinder 3 feet 3 inches long, which is also braced to the vertical posts of the framework and to the face of the rock cut.

The rams are 30 inches exterior diameter, with a 2.5-inch thickness of metal, and are cast in one piece. On the upper end is bolted a top casting supporting a shaft which carries at each end two chain sheaves and a crosshead, the latter working in vertical slides, bolted to the framework. The rams and presses are calculated for a working pressure of 1,000 pounds per square inch, and should be tested to 2,000 pounds per square inch before erection.

The average weight suspended from each ram is 67.7 tons. This weight is carried by two 2½-inch chains, each of which should be 100 tons proof. The fixed ends of the chains are attached to the guide-cylinder castings and the running ends to the side trusses of the platform, three sheaves being interposed on each chain to give the desired multiplication.

The platform is composed of two side trusses 170 feet long and forty feet between centers. They support the ends of the transverse trusses. The latter are 11 feet 3 inches between centers, are symmetrically placed with regard to the rams, and support four stringers, one under each rail. The side trusses are formed of four angles 5 inches by 5 inches by ½ inch; two cover plates at both top and bottom, 18 inches by ½ inch; and a web plate 48 inches by 7/16 inch. The track stringers are formed of one cover plate, top and bottom, 9 inches by ⅜ inch; four angles 2½ inches by 2½ inches by ⅜ inch; and web plate 18 inches by ⅜ inch. The cross girders are the same as the side trusses, except that the web plate is 45 inches by 7/16 inch.

The framework is composed of vertical posts connected at their centers and upper ends by horizontal struts, the whole being braced longitudinally by diagonal tie-rods and laterally by inclined struts anchored to the rock in place. The vertical columns are built up of ½-inch plates, 4-inch by 4-inch by ½-inch angles, and 12-inch channel bars. The latticing is of 2½-inch by ⅜-inch bars, and the whole is proportioned to support the weight of the platform and its load. The upper horizontal strut is a hollow-built beam, without bottom plates, and is formed of ½-inch plates and 4-inch by 3-inch by ½-inch angles. It is placed above the extreme position of the rams, and supports the hydraulic pipes and the shafts, bearings, and valves of the regulating mechanism.

The platform is supported in its elevated position as follows: On each side of each ram a 12-inch rolled I-beam is placed horizontally at the necessary height. The inner end is supported by the vertical posts just mentioned. The outer end is anchored to the rock in place, when the latter is high enough; otherwise it is supported by the inclined lateral struts and anchored to the rock by vertical rods. This I-beam supports a movable I-beam or chock, the outer end of which clamps over the lower beam for holding down. The entire system of chocks is operated together. Each chock is connected to the center arm of a double bell crank. Each of the other arms of the crank is attached to one of two rods which extend the full length of the lift. Each of these rods is operated by a small hydraulic ram, by means of which the line of chocks can be moved into place beneath the platform or withdrawn.

The load will not be uniformly distributed to all the rams of the lift, and the ram with the smallest load would, unless controlled, rise faster or descend slower than any other. To cause all the rams, independent of their respective loads, to move at the same speed, and thus maintain the platform horizontal and free from undue strain, is the object of the regulating mechanism.

Mr. G. W. Dickie, the designer and constructor of the Union Iron Works lift, devised for application to that lift a regulating mechanism that has given satisfaction. The principle of this device is adopted for the Dalles lifts, with such modifications in details as were suggested by experience. The arrangement of this device is shown on the drawings with the report mentioned above, and is as follows:

On each side of the lift a horizontal shaft is placed in bearings on the upper horizontal strut of the framework. The shafts extend the length of the lift, are geared to the same engine shaft and at each ram by a worm gearing to a vertical shaft. The latter has on the guide cylinder a bearing for its lower end and on the valve box casting a bearing for its upper end. The bearings and gearing permit of a small vertical motion to the shaft. It is screw-threaded for a length somewhat greater than the stroke of the ram, and has threaded upon it a nut or sleeve, that is carried by the top casting of the ram. The sleeve is made in two parts, drawn together by bolts to take up any lost motion on the screw thread. The upper end of the vertical shaft is attached to one end of a lever, to the other end of which is attached the valve stem. The valve is of the ordinary slide pattern, with two ports—the upper in connection with the return or exhaust pipe and the lower with the interior of the press. The interior of the valve box is in connection with the supply pipe.

Power is furnished by a pair of direct-acting steam-pumping engines of about 500 total horse power. The stroke is 36 inches, the diameters of the steam and water cylinders are 26 inches and 8 inches, respectively, and the piston rod, 4 inches in diameter, extends through both heads of the water cylinder. With 80 pounds average steam pressure and 30 revolutions per minute the pumps will furnish 162,000 cubic inches, or 700 gallons, per minute, under a pressure of 1,000 pounds per square inch.

Supply pipes deliver the water at all points and return pipes bring it back to the tank. Valves are so placed that any portion of the hydraulic machinery can be cut off without interference with the rest of the system. An accumulator of small capacity is connected with the supply pipes to receive any excess or supply any deficiency in the amount of water furnished by the pumps. It also automatically controls the speed of the pumps, through a connection between the steam throttle and the ram of the accumulator, such as to open the throttle as the ram falls and to close it as the ram rises.

The operation of the pumping plant and the regulating mechanism is as follows: The lift being at rest, the position of the regulating valves is as shown on the drawing. The connections between the presses and both the supply and return pipes are closed and the pumps furnish only water to supply leakages. To raise the platform the engine of the regulating mechanism is started in the direction to wind the vertical screw-threaded shafts down through the sleeves on the ram heads. The rams being at rest, the shafts are carried bodily downward, the slide valves rise, the lower ports are opened, water flows into the presses, and the rams move upward, carrying the platform 4 feet for 1 foot of movement of the rams. This continues so long as the upward speed of the rams is the same as the speed with which the shafts are wound down through the sleeves. If the speed of the rams is less than this regulating speed the shafts are carried farther down and the ports are opened more fully. If the speed of the rams is greater the shafts are carried upward and the ports are partly closed. Should the load on any ram be less than any other the water will seek that press more freely, the ram will rise faster than the others and than the regulating speed, and will carry the shaft upward, partly or wholly closing the valve, which will be opened again when that particular ram is again in unison with the others. Similarly for an overloaded ram the valve will be opened more fully.

The entire operation is automatic, outside of the engine of the regulating mechanism, the direction and the speed of which are so adjusted as to give the desired direction and speed to the lift. When the engine is started for raising the lift the valves open and water is drawn from the accumulator. The ram of the accumulator falls, and the steam throttle of the pumps is opened, until an equilibrium is established and water is supplied in the quantities called for by the speed of the regulating mechanism. The entire operation is under the control of the regulating engine, of course within the limit of the capacity of the pumps.

The platform is raised slightly above the track level, and the regulating engine is stopped. The chocks are moved into position under the platform by operating the proper rams, and the platform is gently lowered upon them by reversing the regulating engine.

To lower the platform it is first raised sufficiently to clear the chocks, which are then withdrawn. The engine is reversed, winding the vertical shafts up through the sleeves. The valves are carried down, connections are made between the two ports, the water flows from the presses through the return pipes back to the tank, and the rams descend under control, as in rising. The operation is similar to that of raising the platform, except that the pumps take no part in it, and the limit of speed is fixed by the ability of the water to escape through the valves and pipes. Practically the speed in lowering is considerably greater than in raising.

The platform and all the framed portions of the lift are of mild steel and calculated for a maximum strain of 10,000 pounds per square inch. Provision is made in the side trusses for carrying the load to the adjoining rams in case of one ram being disabled. The weight of the platform is 184 tons. The weight of the car is 300 tons and of the boat is 600 tons. The total weight suspended from the chains is 1,084 tons, and the average weight per ram is 67.75 tons. The weight of each ram and attachment is 23.4 tons. The weights of car and platform are uniformly distributed, but the weight of the boat is not. The same assumption as to the distribution of its weight as was made in the calculations for the car gives as the maximum load suspended from the center rams 79.7 tons. The maximum total pressure on these rams is four times the maximum suspended load, 79.7 tons, with an addition of 23.4 tons for the weight of the ram and its fixtures. The total pressure is, therefore, 342.2 tons, and the maximum pressure per square inch is 970 pounds. The speed proposed for the platform is 4.5 feet per minute, corresponding to a speed of 1.12 feet per minute for the rams.

At any stage of the river all the portions of the lifts for operating at that stage will be above the water, with the exception of the lower bearings of the vertical regulating shafts and portions of the rams and of the supply pipes leading to the presses. The platform of the Dalles lift will be only submerged at extreme high water, a stage of the river of short duration and of rare occurrence. The engine and boiler houses will be conveniently located and above all stages of the river.

Each of the lifts is placed in a chamber excavated for it, with an entrance from the river of suitable width and depth. The lift chambers will be lined with heavy masonry walls carried up to the bases of the presses of the lifts. The face of the lifts will be lined similarly to the level of the tracks. Above the bases of the presses the sides of the chambers will be excavated to a suitable slope with an offset 8 feet in width at the top of the masonry walls. The character of the rock may prove to be such as to modify the work proposed.

[NOTE.—The maps and plans accompanying the report are not here reprinted. Printed in Senate Ex. Doc. No. 7, Fifty-third Congress, first session.]

APPENDIX W W.

SUPERVISION OF THE HARBOR OF NEW YORK.

REPORT OF LIEUT. COMMANDER DANIEL DELEHANTY, U. S. NAVY, SUPERVISOR OF THE HARBOR OF NEW YORK, FOR THE FISCAL YEAR ENDING JUNE 30, 1894.

OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
New York, July 9, 1894.

GENERAL: I have the honor to submit herewith a report of the duties and operations of this office for the fiscal year ending June 30, 1894; also an estimate of the amount required for the fiscal year ending June 30, 1896.

On October 2 last I assumed charge of the supervisor's office, relieving Capt. Frederick Rodgers, U. S. Navy.

The act of Congress approved June 29, 1888, creating this office was urgently demanded by the necessities of the case. The millions of tons of refuse material, consisting of dredgings from the harbor, from excavations on shore, débris from city improvements and city refuse of all kind, were transported over the waters of the harbor and deposited at the convenience of the contractors with an utter disregard for the maritime interests of the port, notwithstanding the fact that the practice of depositing obstructive and injurious material in these tidal waters has been since 1857 illegal under the laws of the State of New York and also under the laws of New Jersey since 1882. Earnest attempts were made by the two boards of commissioners of pilots of New York and New Jersey to protect the harbor under these State laws, but with indifferent success, owing chiefly to a lack of funds to organize an efficient patrol and to a divided responsibility.

The effect of this office is shown in the marked abatement of illicit deposits. It has so far been impossible to rigidly enforce the law, for the reasons that the force required to watch the large area over which this office has jurisdiction is inadequate, and the laws enacted for the protection of the harbor have been found to be so defective as to afford abundant means of escape for manifestly guilty parties.

My predecessors for the past four years have earnestly urged the necessity for two additional tugs for patrol duty. A renewal of this recommendation is now under consideration by Congress.

The importance of a constant and vigilant patrol of these waters can not be overestimated. Unless it is maintained it would be cheaper for the Government to relieve the contractors of the expense of towing and do the work for them.

The cost of removing the enormous amount of refuse material from the water front of New York City, Long Island, and the New Jersey shores of the harbor to a necessarily distant point of deposit is a large item of the expense of handling it, and the temptation to dump short is therefore great.

Soon after assuming charge of this office I carefully examined all the records concerning reports of violation of the law and the subsequent actions of the law authorities on the same, in order to determine the various defects in the laws with the view to their amendment. As a result of this examination, I had the honor to submit for your action the accompanying letter and memorandum (marked A), which received your approval, and under your direction a draft of amendments to the act approved June 29, 1888, entitled "An act to prevent obstructive and injurious deposits within the harbor and adjacent waters of New York City, by dumping or otherwise, and to punish and prevent such offenses," was made from the accompanying memorandum and submitted to the honorable Secretary of War with your recommendation that it be transmitted to Congress "for such action as the important interests involved demand." The amendments were favorably acted upon by the House of Representatives and are now under consideration in the Senate.

A refuse buoy has been located off Coney Island for many years to mark the point for the deposit of all city refuse. On investigation I found the character of the refuse deposited there to be largely of a heavy material, such as ashes, which was working a serious injury to the east channel.

On February 2 I addressed the mayor of New York, inviting his attention to the matter, and explained the necessity for a change of method of disposing of the refuse. I submitted to him these propositions:

First. Cremation of the entire city refuse.

Second. Separation of garbage from other refuse and the deposit of each at respectively designated points.

Third. The deposit of all the refuse in deep water outside of Sandy Hook Light-Ship.

No definite action having been taken on my letter, on March 28 I notified the city, through the mayor, that on and after April 1, 1894, the refuse material complained of must be deposited outside of Sandy Hook Light-Ship, excepting such as may be permitted by the board of health to be used for filling purposes.

Subsequently a similar arrangement was made with the mayor of Brooklyn, extending for that city the time of its taking effect until May 1, after which date the refuse buoy off Coney Island was removed.

Through the courtesy of the Light-House Board and Capt. W. S. Schley, U. S. Navy, the inspector of the third light-house district, the keepers of the Sandy Hook light-ship were directed to cooperate with this office to insure a compliance with its regulations concerning the deposit of refuse in vicinity of light-ship, and the following was promulgated:

REGULATIONS GOVERNING THE DEPOSIT OF REFUSE OUTSIDE OF SANDY HOOK LIGHT-SHIP.

WAR DEPARTMENT,
OFFICE OF THE SUPERVISOR OF THE HARBOR OF NEW YORK,
ROOM A8, U. S. ARMY BUILDING, 39 WHITEHALL STREET,
New York, April 6, 1894.

On and after the 10th instant all material containing garbage and all refuse which will float on the water must be deposited to the southward and eastward of Sandy Hook light-ship in not less than 15 fathoms of water.

Time of deposit must be from one hour to two and one-half hours after high water at Sandy Hook. The time of high water at Sandy Hook to be taken from the tables published by the U. S. Coast Survey, New York standard time.

If any cargo is only partially discharged within the above specified time, the remainder shall not be deposited until a subsequent ebb tide and within the specified time.

Fog, stress of weather, or any other cause shall not operate to release the owners or masters and employés of scows and towboats from the penalties imposed for illegal dumping.

No scow or dumpers shall be discharged except by order of the master of the tug having the same in tow. This order shall be signaled by four sharp blasts of the steam whistle when the tow reaches the dumping ground.

The permits will be collected by the patrol boats as usual.

Before dumping, the tows shall pass close to the Sandy Hook light-ship, having due regard to safety, call the attention of the light-ship by steam whistle and report the name of tug, and not proceed until directed by light-ship to "go ahead."

D. DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

While the result of this change was a marked improvement in the condition of the lower bay, the nuisance from which that section had for so long a time suffered was not abated, and it became apparent that the deposit at the mud buoy of what is technically known as cellar dirt, the débris from city improvements, was largely responsible for its condition. Contractors engaged in removing this material were notified that their applications for permits to deposit cellar dirt at the mud buoy must be accompanied by a certificate that it contained no floatable material. This regulation, as a rule, is carefully complied with and with good results. The practice, however, of depositing material of any kind in the tidal waters is to be greatly deprecated. Through the action of the currents more or less of the solid matter finds its way to the channels, to be eventually removed at Government expense; and as it seems impossible to free it entirely of injurious floatable material, it creates a perennial nuisance on the water and the shores of the off-lying summer resorts. Its proper disposition should be for filling-in purposes behind properly constructed crib work. An effort is now being made in this direction.

A large proportion of the refuse of New York City is now being used to fill in the flats of Rikers Island. This island is the property of New York City and is located in the East River near the entrance to Long Island Sound. The city has authority from the War Department to build a crib work on the shoal at the 12-foot curve and to fill in behind it, which will increase the area of the island nearly 400 acres. The crib work around the shoal on the west side of the island is completed and the city is depositing within it daily over 4,000 cubic yards of ashes, garbage, and refuse of all kinds. The odors arising from this refuse are extremely offensive.

During the winter I made a personal examination of the various city dumps, and it was clearly evident that the material collected at these points was unfit for filling-in purposes. In the summer season it would prove a menace to the public health and an intolerable nuisance in the harbor. I invited the attention of the board of health to the character of the refuse, and protested against its use for filling-in purposes. I submit the correspondence, marked B, which will show the efforts of this office to prevent what has resulted in a great evil in the harbor from the deposit of this material.

The methods of loading, transporting, and discharging it are also highly objectionable, as large quantities of obstructive and floatable matter get overboard, to the injury of the channels and the fouling of the waters and adjacent shores. Numerous complaints have been made against these evils by the residents in the vicinity of the island, the steamboat captains running between the East River and the sound, and by the deputy inspectors of this office. This matter has been repeatedly called to the attention of the local authorities, who have promptly responded with efforts to correct the evils complained of, but the trouble is that the system under which the work is done is crude and faulty.

On the approach of the summer season I notified the commissioner of the department of street cleaning "that improved methods for disposing of this material must be adopted with as little delay as possible, otherwise our respective departments will be subjected to severe and just criticism."

The mayor and commissioner of the department of street cleaning accompanied me on a tour of inspection, during which the defects of the system employed were clearly seen and an earnest endeavor to make a radical and satisfactory change was promised on their part.

The following propositions were made by Mr. Andrews, commissioner of street cleaning department:

First. To use dumpers exclusively, and to erect at each dump large bins for the reception of the refuse from which to load the dumpers through chutes.

This would prevent the fouling of the slips while loading and the escape of the matter during transportation, as is now invariably the case with the deck scows in use.

Second. To deposit the material behind the crib by means of pumps.

Third. To establish a plant on the island at once to disinfect and deodorize the refuse.

Fourth. To permit contractors to deposit dredged material and cellar dirt behind the crib work by a system of pumping. This would serve as a cover to the refuse as required by the board of health, which is a sanitary measure of great importance.

The adoption of these proposed changes would satisfactorily solve the main problem for the protection of this harbor.

Besides the advantages above enumerated, the city would save on all tows from the North River 20 miles of towage, and from the East River from 20 to 50 miles; and to the cellar dirt and dredging contractors there would be a saving of 10 to 30 miles of towage, depending on the location of the point where loaded.

This would materially lessen the temptation to dump short.

It would also practically confine the tows to the rivers, where they could be more closely watched than in the open waters of the bays.

It would be a decided advantage to discontinue the practice of depositing material off the entrance to the harbor. It was originally permitted in order to reduce the depth in a hole off Coney Island, but experience has shown that a large proportion of this material finds its way to the channels.

The depositing of material of any kind in the tidal waters of this harbor should be absolutely prohibited.

If the material should be utilized for filling in the numerous shoals within the harbor that could be advantageously reclaimed, the land made in this way would be of great value, and with the adoption of some such method as was employed for filling in at League Island the comparative cost would be trifling.

Many complaints have been made to this office of the frequent obstruction to the ship channels by numerous small craft engaged in raking for clams to the serious inconvenience and danger to the large vessels using these channels. After diligent inquiry, I could find no legal authority for abating this nuisance to the commerce of the port.

In consultation with some of the principal representatives of the shipping interests and the New York pilots it was clearly shown that it had become a necessity to procure a legal remedy for the evil, and I therefore drew up, with the advice of the parties named, the following proposed amendment to the law approved June 29, 1888, which was submitted to the Department with the request that it be forwarded to the Committee on Commerce, which committee had then under consideration the river and harbor bill containing other proposed amendments to that act:

PROPOSED AMENDMENT to an act supplementary to an act approved June 29, 1888, entitled "An act to prevent obstructive and injurious deposits within the harbor and adjacent waters of New York City, by dumping or otherwise, and to punish and prevent such offenses."

It shall be unlawful for any person or persons to engage in fishing or dredging for shellfish in any of the channels leading to and from the harbor of New York, or to interfere in any way with the safe navigation of those channels by ocean steamships and ships of deep draft.

Any person or persons violating the foregoing provisions of this section shall be deemed guilty of a misdemeanor, and on conviction thereof shall be punished by fine or imprisonment, or both, such fine to be not more than two hundred and fifty dollars nor less than fifty dollars, and the imprisonment to be not more than six months nor less than thirty days, either or both united, as the judge before whom conviction is obtained shall decide.

It shall be the duty of the United States supervisor of the harbor to enforce this act, and the deputy inspectors of the said supervisor shall have authority—

1. To arrest and take into custody, with or without process, any person or persons who may commit any of the acts or offenses prohibited by this act: *Provided*, That no person shall be arrested without process for any offense not committed in the presence of the supervisor or his inspector or deputy inspectors, or either of them: *And provided further*, That whenever any such arrest is made the person or persons so arrested shall be brought forthwith before a commissioner, judge, or court of the United States for examination of the offenses alleged against him; and such commissioner, judge, or court shall proceed in respect thereto as authorized by law in case of crimes against the United States.

2. To go on board of any vessel guilty of a violation of this act, and to seize and hold such vessel until it is discharged by action of the commissioner, judge, or court of the United States before whom the offending persons are brought.

There has been moved and deposited into the waters outside the harbor at properly designated places and behind bulkheads in the neighborhood of New York, during the fiscal year ending June 30, 1894, the amount of 9,172,688 cubic yards of material, mud, city refuse, garbage, cellar dirt, ashes, acid, lime, and other material, as per the following recapitulation:

Place of deposit.	Kind of material.	Amount.
		Cubic yards.
Mud Buoy	Mud, etc	4,940,322
Refuse Buoy	City refuse, etc., to April 10	1,121,700
Scotland Light-Ship	Mud, etc	383,603
Sandy Hook Light-Ship	City refuse, etc	245,785
Long Island Sound	Mud, etc	587,363
Casanova, Long Island Sound	City refuse, etc., behind bulkheads for filling	239,325
Harts Island, Long Island Sound	do	102,800
Rikers Island, Long Island Sound	do	619,800
North River	Dirt, ashes, etc., behind bulkheads and on shore for filling.	439,969
East River	do	94,960
Harlem River	do	70,940
Raritan River	do	8,845
New York Bay	do	13,680
Passaic River	do	25,190
Newark Bay	do	132,248
Staten Island Sound	do	19,860
Jamaica Bay	do	31,688
Princes Bay	do	28,000
Shrewsbury River	do	4,522
Elizabeth River	do	5,217
Hackensack River	do	550
Barren Island	Acids, dead animals, etc., on shore in store	56,321
Total		9,172,688

Permits issued, 8,108.

From the foregoing statement it will be seen that 7,278,773 cubic yards of mud, city refuse, etc., were deposited near the mouth of the harbor, and that 1,893,915 cubic yards of dirt, ashes, and other inoffensive material were used for filling in behind bulkheads, reclaiming land, etc., for which special permits were issued.

The following is a statement of the appropriations made for "prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City," 1894:

For pay of inspectors, deputy inspectors, office force, and expenses of office		$15,000.00	
Expended to July 1, 1894	$13,270.32		
Outstanding liabilities	1,276.78		
		14,547.10	
Balance			$452.90
For pay of crew and maintenance of steamer *Nimrod*		10,000.00	
Expended to July 1, 1894	9,348.39		
Outstanding liabilities	639.39		
		9,987.78	
Balance			12.22
For pay of crew and maintenance of steamer *Argus*		8,000.00	
Expended to July 1, 1894	7,602.05		
Outstanding liabilities	358.19		
		7,960.24	
Balance			39.76
Total balance of appropriation July 1, 1894			504.88

The following is an estimate of appropriation required for service of the fiscal year ending June 30, 1896, by the supervisor of the harbor of New York:

Detailed objects of expenditure and explanations.	Estimated amount that will be required for each object.	Amount appropriated for fiscal year ending June 30, 1895.
Prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City:		
For pay of inspectors, deputy inspectors, office force, and expenses of office	$20,000	$15,000
For pay of crew and maintenance of steamer *Nimrod*	10,000	8,000
For pay of crew and maintenance of steamer *Argus*	10,000	8,000
For pay of crew and maintenance of one steam tug to be purchased or constructed	12,000	....
For the purchase or construction of one steam tug	45,000	45,000
For pay of crew and maintenance of one steam tug to be purchased or constructed	12,000	....
Total	109,000	76,000

Very respectfully, your obedient servant,

DANIEL DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

A.

LETTER OF THE SUPERVISOR OF THE HARBOR OF NEW YORK.*

WAR DEPARTMENT,
OFFICE OF THE SUPERVISOR OF THE HARBOR OF NEW YORK,
New York, November 24, 1893

GENERAL: I have the honor to invite your attention to some of the difficulties attending the enforcement of the act of June 29, 1888, for "prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City."

I am satisfied that this law is repeatedly violated, tugboat employés, contractors, and their employés taking every advantage to deposit prohibited material in the channels of this harbor. Many cases have been reported and investigated by this office, those sustained by affidavits being forwarded to the Department, with recommendations that proceedings be instituted against the parties liable. The outcome has almost invariably been an opinion by the law authorities that under the statutes a prosecution could not be sustained. This tends to produce a contempt for the law on the part of those whose interest lies in violating it, and it is clear to me that unless the law is amended it will be impossible to properly protect these waters against illegal dumping.

I forward herewith suggestions for amendments to the act, with an appendix of cases bearing on each proposed clause, and, should the matter meet with your approval, I respectfully request that you will have a draft of amendments prepared and furnish me with a copy of same.

It is earnestly hoped that the much-needed amendments to the present law may be favorably acted upon during the coming session of Congress.

Very respectfully, your obedient servant,

D. DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Memorandum showing the necessity of certain amendments to the act of June 29, 1888, chapter 496, to prevent injurious deposits in the harbor and adjacent waters of New York.

1. Deputy inspectors to have authority to arrest all persons guilty of illegal dumping (see case F. N. Brown, appendix, p. 2690) or for moving prohibited material without a permit, and authority to seize, hold, and place deputy inspector on board until action be had by the courts. If these officers should be invested with this authority I believe it would effectually break up the practice of illegal dumping.

2. Penalty for tows not returning to office of supervisor within forty-eight hours, such permits as may not be taken up by inspectors. Such permits must bear an indorsement by the master of tug, or the owner or person acting in such capacity, stating whether or not the permit has been used, and if it has been used, the time and place of dumping.

3. Every scow or dumper engaged in the transportation of dredgings, earth, sand, mud, cellar dirt, garbage, or other offensive material of any description shall have its name or number and owner's name painted in letters and numbers at least 14 inches long on both sides of the scow or dumper, these names and numbers to be kept distinctly legible at all times, and the deputy inspector to have authority to prevent any scow or dumper not properly marked being used to dump any such material.

The above is a regulation of the supervisor's office, but as it has not the authority of law it is difficult to enforce it.

4. Deputy inspectors to have authority to arrest witnesses to illegal dumping, such witnesses to be released under proper bonds. (This is necessary in cases of employés on scows, who easily escape, and generally they are the chief offenders.)

5. Penalty for bribing, or attempting to bribe, any employé of the supervisor's office to permit or overlook illegal dumping.

6. Penalty for masters of tugs (revocation of license) and owners (fine of ——— dollars) for not taking out permits before moving prohibited matter. (See cases *Ceres*, appendix, p. 2689, and *C. C. Waite*, appendix, p. 2689.)

7. It is important that a law should be enacted covering cases showing conclusively that illegal dumping has been committed, but where absolute proof can not be obtained by the deputy inspector.

It has frequently occurred that tows bound for the dumping buoys in thick weather pass the inspectors' boats, deliver their permits, and within a time impossible for them to have reached said buoys are found empty. They have clearly been illegally dumped, but by decisions of the law authorities the Government has no redress.

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* Printed in House Ex. Doc. No. 57, Fifty-third Congress, second session.

Attorney-General W. H. H. Miller says, in the case of the tug *C. C. Waite* (appendix, p. 2689), we should be compelled to prove that the load had been dumped. This is the *corpus delicti* and is to be directly and not inferentially proved, no matter how irresistible the inference.

8. Again, offenders have escaped prosecution by simply claiming that the illegal deposit was made by a mistake of an irresponsible scowman. (See case of *F. N. Brown*, appendix, p. 2690.) I am satisfied that these "mistakes" are, as a rule, premeditated, and would practically cease it it were understood that the perpetrators were liable to prompt arrest by the deputy inspectors. In a case of this nature it was decided by the court "that neither was the master of the tug 'a person offending within the meaning of the act, nor was the tug 'used or employed' in the act of the scowmen." (See case of *Emperor*, appendix, p. 2690; also case of *F. N. Brown*, p. 2690.)

9. The law is evaded in several other ways, viz:

(1) By claiming that the dumping was necessary through defect in machinery or accident to tug. (See case of *S. Decatur*, appendix, p. 2691; also tug *Ceres*, appendix, p. 2692.)

(2) Towing scows out in bad weather and then dumping, pleading that it was necessary to save life and property. (See cases of *W. E. Ferguson* and *Tacoma*, appendix, p. 2692.)

(3) Taking too many scows in tow, losing control of them, or deliberately permitting them to go aground, and then dumping on the plea of necessity. (See case of tug *Howard Carroll*, appendix, p. 2691; also tug *Robert Robinson*, appendix, p. 2692.)

10. Authority for deputy inspectors to enter gas and oil works for the purpose of discovering the disposition made of the sludge acid. It has been allowed to run into the water contrary to law, and it is presumed that in some cases this is done by means of underground pipes.

11. It has been reported that tramp steamers entering this port frequestly discharge their ballast just outside the bar. If this practice continues it will undoubtedly in time prove dangerous to navigation. The law authorities of the Government have decided that the United States has no jurisdiction at a distance of more than 3 miles from the shore at low-water mark. To cover this point the following is proposed:

Proposed draft of an act to prevent the dumping of ballast or other bulky material in the approaches to New York Harbor and Bay off Sandy Hook.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That any vessel or vessels from which may be dumped or discharged ballast or other bulky material in the approaches to New York Harbor and Bay within fifteen miles of the Sandy Hook Light-Ship, or in less than sixteen fathoms of water, shall not be allowed by the collectors of customs to receive passengers or cargo, or clear from New York or any port adjacent to New York Harbor and Bay for the period of six months from the time of the commission of such dumping or discharging of ballast or other bulky material.

SEC. 2. That it shall be the duty of the supervisor of the harbor of New York, appointed and acting under the provisiens of an act entitled "An act to prevent obstructive and injurious deposits within the harbor and adjacent waters of New York City, by dumping or otherwise, and to punish and prevent such offenses," approved June twenty-ninth, eighteen hundred and eighty-eight, to detect by proper measures any vessel or vessels which may dump or discharge ballast or other bulky material within the limits specified in the foregoing section of this act, and upon being satisfied of the commission of such act or acts to report the same to the collectors of customs at ports adjacent to New York Harbor and Bay for action by them in pursuance of the provisions in the said foregoing section; and the provisions of the said act approved June twenty-ninth, eighteen hundred and eighty-eight, and the jurisdiction of the said supervisor of the harbor of New York are hereby extended, so far as they are applicable and consistent with the provisions of this act, to embrace the waters included within the limits specified in section one of this act.

SEC. 3. That the collectors of customs at any or all the ports adjacent to New York Harbor and Bay, upon receipt of information from the said supervisor of the harbor of New York that any vessel or vessels have dumped or discharged ballast or other bulky material within the limits specified in section one of this act, are hereby authorized and directed not to allow said vessel or vessels to receive passengers or cargo or clear from the respective ports within six months from the time of commission of such dumping or discharging of ballast or other bulky material, as provided in section one of this act.

APPENDIX.

CASES AGAINST THE TUG CERES.

In this case a deputy inspector boarded the *Ceres* and demanded to see the permit for moving the loaded scows then comprising her tow. The *Ceres* had no permit, and the deputy inspector's affidavit to that effect was forwarded to the Department with recommendation that the parties liable be prosecuted under section 3 of the act of June 29, 1888.

Referring to this case, the district attorney for the southern district of New York says:

"I have considered this matter, and come to the conclusion that no prosecution can be sustained under section 3 against the master of the *Ceres* or the master of the dumper for their failure to obtain the permit as required by such section."

Affidavits by a deputy inspector stationed at the Narrows that the tug *Ceres* passed through the Narrows, outward bound, with a loaded dumper in tow, and affidavit by the master of the steamer *Nimrod* that he ran alongside said tow when off the bell buoy and Coney Island Point and found said dumper in tow of the *Ceres* light, and that the material must have been illegally deposited between the Narrows and the bell buoy, were forwarded, and prosecution of the parties liable recommended.

In reference to this case the district attorney says:

"The defendant was discharged on the ground that the dumping with which he was charged was done through necessity and for the purpose of saving the scow."

CASE AGAINST THE TUG C. C. WAITE.

In this case affidavit by the deputy inspector stationed at the Narrows that the *C. C. Waite* had passed the Narrows, bound out, with a tow of loaded scows without a permit, being in violation of sections 3 and 4 of the act of June 29, 1888, was forwarded to the Department for opinion.

The following opinion was rendered by the honorable Attorney-General, W. H. H. Miller:

"The supervisor of the harbor of New York, in his letter to the Chief of Engineers, states that the tug was overhauled by the patrol boat and the officers requested to show their permit from the supervisor to dump the load which it had in tow. It was found that they had no permit, and you therefore recommend action under sections 3 and 4 of act of June 29, 1888 (25 Stats., 209). Section 3 of this act provides:

"'That it shall be the duty of the owner or master, or person acting in such capacity, on board of such scows or boats, before proceeding to take or tow the same to the place of deposit, to apply for, and obtain from the supervisor of the harbor appointed hereunder, a permit defining the precise limits within which the discharge of such scows or boats may be made; and any deviation from such dumping or discharging place as specified in such permit, shall be a misdemeanor within the meaning of this act, and the master and engineer, or person or persons acting in such capacity, on board of any towboat towing such scows or boats, shall be equally guilty of such offense with the master or person acting in capacity of master of the scow, and be liable to equal punishment.'

"While the provision is that the person in charge of the tug shall obtain a permit, yet his failure to do this is not made an offense, and I do not think that the evidence that he had in tow a load of mud to be dumped, and had no permit to show, would be evidence to prove that he had deviated from the 'dumping or discharging place as specified in such permit.' We should be compelled to prove that the load had been dumped. This is the *corpus delicti*, and is to be directly, and not inferentially, proved, no matter how irresistible the inference. The same reason would apply to the offense under section 4, and the papers are therefore returned with the recommendation that unless evidence of the dumping can be obtained no further action be taken.

"W. H. H. MILLER,
"*Attorney-General.*"

The following indorsements are filed with the foregoing opinion:

"OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
"*New York, November 23, 1891.*

"The records of this office show that the scows in question passed the inspector's boat at the Narrows at 11:40 p. m. of the 17th of October, loaded with material to be dumped, and passed in through the Narrows at 4:45 a. m. of the 18th, empty. This conclusively shows that the scows were dumped somewhere outside the Narrows. Whether the dumping took place at a prohibited spot is not known.

"On the 19th of October the owners of the scows applied at this office thro agent for a permit to cover this dumping which had taken place two days prev

"Appended hereto is a copy of a statement by the Atlantic Dredging Co and an additional affidavit by Deputy Inspector Halliday regarding the t which the tow passed in empty."

"OFFICE CHIEF OF ENGINEERS, U. S. A

"It will be seen from the letter of the Attorney-General that the proof of ing is required, and it is regretted that the *Alert* did not or could not follow C. C. Waite and thus secure the evidence desired by the Department of Justice.

"It is suggested, for consideration by Capt. Robeson, whether in future it m practicable for the inspectors connected with his office to follow tugboats w may be presumed that a violation of the law is intended. Possibly, in this the boat in charge of the inspector was not suitable to go outside the bar."

The supervisor in reference to the foregoing indorsement replies:

"In regard to the *Alert* not following out the tug *C. C. Waite*, I would state neither the [illegible] nor the *Alert* are suitable boats to go to sea, except in sm water. They are open boats, with low freeboard, and of but little steam po The orders from this office to the inspectors are to follow the tows to sea as f practicable, whenever the weather permits. The *Nimrod* is usually stationed off tons Point, with orders to follow tows to sea. This she can do under all condit of weather. On the night of the 17th of October I find that she was laid u slight repairs, and the inspector in charge of the *Alert* informed me that the wea was too rough for his boat to go outside the Narrows.

"At present the *Nimrod* and the small naphtha launch are the only boats avail for use in this office for patrolling purposes, the naphtha launch being only fit inside work."

CASE AGAINST THE TUG F. N. BROWN.

In this case affidavits by two deputy inspectors in regard to the illegal dump of scow No. [illegible] in tow of the *F. N. Brown*, when off Coney Island Point, also affida by the master of the *F. N. Brown* admitting the illegal deposit of material, b claiming that the deposit was made by a mistake of the scowman, were forward to the Department with recommendation that proceedings be instituted against t parties liable.

Referring to this case, the district attorney for the southern district of New Yo says:

"I beg to say that I have carefully examined into this matter and have endeavore to obtain the necessary witnesses to show that the scow in tow of the tug *F.* *Brown* was dumped within the prohibited limits, but have been unable to do so, s in view of the above, it seems to me that it is inexpedient to prosecute the case."

The papers in this case were returned to the Department with the following indorsement:

"OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
"*New York, July 11, 1892.*

"The affidavits of the deputy inspectors belonging to this office state that the [illegible] material at some other place [illegible] by the master of the *F.* *N. Brown*.

"[illegible] see the deposit [illegible] sufficient evidence to [illegible] deposited through the [illegible] the person in charge."

[illegible]

[illegible] illegal dumping by [illegible] North River, and the Nar- [illegible] *N. Brown*, admitting the [illegible] orders, were for- [illegible]

[illegible] of June 29, 1888, I [illegible]

[illegible]

[illegible]

[illegible]

[illegible] Affidavits by Deputy [illegible] and by Dep- [illegible] boarded the tow off Coney

Island Point and found the same light, and that the material must have been illegally deposited between the Narrows and Coney Island Point, were forwarded to the Chief of Engineers, U. S. Army.

[Extract from Seaboard, December 30, 1892.]

1. *United States* v. *The Emperor*, 49 Fed. Rep., 751.

The act of June 29, 1888 (25 Stat. L., p. 209), provides that mud shall not be dumped within certain limits around the port of New York; that every person, firm, or corporation engaged in removing mud shall be responsible for its deposit outside of such limits; that for every violation of the law the person offending shall be deemed guilty of an offense against the act; and that any boat used or employed in violating the provisions of the act shall be liable to a penalty. On suit brought to recover such penalty against a tug, which, with scows, was on her way to the dumping ground in the usual course, and well out to sea, but still within the prohibited limits, when the scowmen, who were in no way connected with the tug, with their volition, and without the knowledge of those on the tug, and contrary to her captain's express orders, dumped the scows. The U. S. district court decides that neither was the master of the tug a "person offending," within the meaning of the act, nor was the tug "used or employed" in the act of the scowmen.

CASE AGAINST THE TUG HOWARD CARROLL.

Affidavits that the *Howard Carroll* had illegally deposited the contents of her tow of two dumpers at the mouth of Coney Island Channel, forwarded June 4, 1890, inclosing affidavits by the master that he had four dumpers in tow, two of which grounded in Coney Island Channel, and in order to save grounded dumpers they were dumped by his orders, and afterwards he proceeded to sea and dumped the remaining two at the mud buoy.

In forwarding the papers in this case the supervisor says:

"Masters of tugs employed in towing dumping scows take more scows at one time than their tugs can handle. Consequently when, from their own carelessness, their tows get in difficulty they dump their loads and plead necessity as an excuse. The only method to check this habit is to subject them to the trouble and cost of defending suits brought against them for illegal action. I therefore recommend that proceedings be commenced."

This case was to be tried October 24, 1892.

CASE AGAINST TUG STEPHEN DECATUR, AUGUST 13, 1890.

Reported as dumping part of tow in Coney Island Channel.

Sworn statement submitted by the master that, owing to some defect in the machinery, the dumper in tow was only partly emptied at the mud buoy, and on the return the tug was disabled and had to anchor in Coney Island Channel, where motion of sea caused scow to dump remainder of her load.

The supervisor recommended that no proceedings be instituted in this case.

CASE AGAINST TUG STEPHEN DECATUR, JUNE 27, 1893.

In forwarding five affidavits by oystermen, residents of Keyport, N. J., the supervisor says:

"I am of the opinion that frequent attempts are made to avoid the conditions of the permits, and the inclosed affidavits seem to me to substantiate a clear violation of the act of June 29, 1888. I therefore recommend that proceedings be instituted against the parties liable."

Under date of October 23, 1893, the U. S. district attorney for the district of New Jersey says:

"I have investigated this matter, and from information received, and which information is supported by affidavits of H. H. Petz, general manager of the Morris and Cumings Dredging Company; of Samuel Hart, foreman of Devine & Betts's shipyard, and of Capt. Briggs, of the said tugboat *Stephen Decatur*, to the effect that the tug at the time complained of met with an accident, which I am satisfied made it necessary for the captain to do as he did. I am therefore of the opinion that the chances of a successful prosecution of this case are doubtful, and I recommend that upon the Morris and Cumings Dredging Company paying expenses that no further action be taken."

A copy of this letter was referred to the supervisor and returned with the following indorsement:

"OCTOBER 30, 1893.

"I consider it most unfortunate if the action in this case be abandoned. I regard it as a strong case for the Government, supported by the affidavits of five different parties that they saw the illegal dumping, and also admitted by the master of the *Stephen Decatur*. The only excuse he makes was accident to the rudder post, which he claims made it necessary for him to dump in Raritan Bay. I consider this no valid reason whatever. The tow was in protected waters, and could have readily been placed in a secure position until another tug had been sent to replace the *Stephen Decatur*. I am thoroughly satisfied that there is much illegal dumping done in these waters, and that a conviction in this case, or even a trial, would have a most salutary effect in deterring others from violating the law. My experience is that the masters of these tugs are very prolific in excuses, and if a conviction can not be had in this case it would greatly increase the difficulty in securing conviction in any case."

CASE AGAINST THE TUG ROBERT ROBINSON, AUGUST 26, 1890.

Reported by deputy inspector that he noticed the tug *Robert Robinson* turn round when off Coney Island Point and ran alongside and found tow dumped.

Affidavits by the master of the *Robert Robinson* and scowman of the tow that the hawser parted while off Coney Island, and before another could be got to them they went ashore on the shoal to the southward, and they had to dump contents to save scows.

Prosecution not recommended.

CASE AGAINST THE TUG CERES, AUGUST, 1891.

Affidavit by the master of the tug *Ceres* that, between Liberty Light and Fort Hamilton, he noticed second scow of his tow higher out of water than when he started, and upon inquiry found that the pin holding wheel on shaft to which chains connecting doors of scow were attached had broken and allowed one door of second forward pocket to dump.

Dismissed by supervisor for want of evidence.

CASE AGAINST THE TUG W. E. FERGUSON, NOVEMBER 15, 1892.

Deputy inspector reported having boarded this tow of three dumpers in Gravesend Bay, and found dumper No. 4 empty.

Affidavit by scowman on scow owned by Ross & Sandford that the storm and rough sea caused the scows to collide, and that No. 4 was injured so badly that she was in danger of sinking, and to save his life he was compelled to dump the mud.

Investigated by supervisor.

CASE AGAINST THE TUG TACOMA, NOVEMBER 10, 1892.

Reported by deputy inspector as having dumped scows in the mouth of the East Channel.

Affidavits by master of tug that the weather was thick, making it impossible to see either Sandy Hook or range lights, he decided to turn eastward to Gravesend Bay, and the tow brought up on the west bank, and as the sea was heavy and a strong wind blowing, he was forced to dump scows to save life and property.

Case filed.

B.

LETTER OF LIEUT. COMMANDER D. DELEHANTY, U. S. NAVY.

OFFICE OF THE SUPERVISOR OF THE HARBOR OF NEW YORK,
New York, February 8, 1894.

SIR: Applications are occasionally made to this office for permits to use garbage for filling-in purposes.

Will you please inform me if there are any objections on sanitary grounds for such disposition of this material.

Very respectfully,

D. DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

THE PRESIDENT OF THE BOARD OF HEALTH,
New York City.

LETTER OF EMMONS CLARK.

HEALTH DEPARTMENT, *New York, February 9, 1894.*

SIR: Yours of the 8th instant to the president of this department has been received. The board of health does not permit the use of garbage for filling-in purposes. During the winter months the board sometimes permits the ashes and street sweepings to be used for filling low grounds adjacent to the city, but not in its built-up portions. In such cases there is more or less garbage in the material used, which it is required shall be raked out from the contents of each cart when dumped, and that it shall be burned. It is also required that where this material is used for filling, the space filled shall be covered with at least 6 inches of fresh earth.

Very respectfully,

EMMONS CLARK,
Secretary.

D. DELEHANTY, ESQ.,
Lieut. Commander, U. S. Navy, Supervisor, New York City.

LETTER OF LIEUT. COMMANDER DANIEL DELEHANTY, U. S. NAVY.

OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
New York, March 7, 1894.

SIR: Referring to the letter of the board of health of the 9th ultimo, wherein it is stated: "The board of health does not permit the use of garbage for filling-in purposes. During the winter months the board sometimes permits the ashes and street sweepings to be used for filling low grounds adjacent to the city, but not in its built-up portions. In such cases there is more or less garbage in the material used, which it is required shall be raked out from the contents of each cart when dumped, and that it shall be burned. It is also required that where this material is used for filling, the space filled shall be covered with at least 6 inches of fresh earth." I understand this to mean that under no circumstances shall garbage be used for filling-in purposes, and that the closing sentence of the board's letter refers to material from which garbage has been eliminated.

Applications are made daily at this office for permits to deposit city refuse at Rikers Island and Casanova. I have made a personal inspection of this refuse and find it composed largely of garbage and sewer excavations; and in view of the rules of the board of health I am of the opinion that it is the duty of this office to prohibit the deposit of this material for filling-in purposes.

I should be pleased to have you and the members of the board of health accompany me on a tour of inspection at your convenience. If you will appoint a time to make this inspection, I shall have a boat ready to convey us to the various points of interest.

Very respectfully,

DANIEL DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

The PRESIDENT OF THE BOARD OF HEALTH,
New York City.

LETTER OF EMMONS CLARK.

HEALTH DEPARTMENT,
New York, March 8, 1894.

SIR: Yours of March 7, addressed to the president of the board of health, has been received, and he requests me to state in reply that this board does not object to the use of ashes, garbage, and street sweepings of this city for filling-in purposes under certain circumstances. When this material is used during the winter months for filling vacant and sunken lots, not in the built-up portions of the city, the board requires the garbage to be raked out as far as possible and burned, but of course this process does not entirely eliminate the garbage. The board has approved the deposit of city refuse at Rikers Island behind cribs properly constructed for that purpose, and approves its use for filling in at any place where it can be deposited below high-water mark and secured by wall or crib, or at such distance from residences that there is no annoyance or detriment to health from the offensive odors necessarily pertaining to such material, to be covered, when the filling is completed, with fresh earth or clean ashes.

Very respectfully,

EMMONS CLARK,
Secretary.

Lieut. Commander DANIEL DELEHANTY, U. S. N.,
Supervisor, etc., New York City.

LETTER OF LIEUT. COMMANDER DANIEL DELEHANTY, U. S. NAVY.

OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
New York, March 13, 1894.

SIR: As an ex-member of the Board of Health of New York City, you are no doubt aware of the fact that a large proportion of the city refuse is used for filling purposes at Rikers Island. This refuse is largely composed of garbage and other objectionable matter, and it is clear to me that it is unfit for the purpose for which it is used. I was confirmed in this opinion by the view held by the board of health, as expressed in accompanying communications. However, when I proposed to prevent further deposit of this material I was met by a remarkable change of front on the part of the board of health, which has compelled me to defer any further action for the present. I inclose the correspondence between the board and this office, which I shall be glad to have you read, and request that you will return it at your convenience.

My object is to induce the city authorities to abandon its present offensive system of final disposition and adopt one of the many modern systems that are working satisfactorily in various cities of the United States.

I assume that you are interested in the subject, as the details of it must be familiar to you, and if you will kindly favor me with your views and otherwise aid in attaining the end sought, your services will be highly appreciated.

Very respectfully,

DANIEL DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

Dr. DANIEL M. STIMSON, M. D.,
New York City.

LETTER OF DANIEL M. STIMSON.

NEW YORK, *March 16, 1894.*

SIR: In reply to your communication of the 13th instant I beg leave to explain that my only connection with the health board of this city was that of a consulting surgeon to certain of its hospitals, and that I am not in anywise an "ex-member of that board;" therefore any opinion of mine upon the subject-matter of your letter would have no specific weight from my former official relations with the health department.

However, as the question involved is of such broad interest to the citizen, and of such particular interest to medical men, presumably *ex-officio* sanitarians, I will venture to express the opinion that, in general, scientific theory and public experience have proven it to be unwise to use material containing any considerable proportion of garbage for filling-in purposes, even although there be a fair amount of tide water covering it. A case where sanitary laws would not demand the elimination of practically all garbage would be an exception. The situation as you present it, in particular, can be viewed from two standpoints, to wit, that of public health and that of public comfort.

As to the first point, I can not now recall any case in which the public health has directly suffered from the emanations from ground made of filling which contained garbage.

On the other hand, as to the second point, there can be no reasonable doubt that the use of garbage filling is almost certain to become a public nuisance on account of the noxious odors to which it invariably gives rise.

I think that an opinion from Dr. E. G. Janeway, of West Fortieth street, a former commissioner of health, would have great weight with reference to this question, and I respectfully suggest that you consider the advisability of consulting him.

Very respectfully, yours,

DANIEL M. STIMSON.

DANIEL DELEHANTY,
Lieut. Commander, U. S. Navy, etc.

LETTER OF LIEUT. COMMANDER DANIEL DELEHANTY, U. S. NAVY.

OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
New York, March 17, 1894.

SIR: I desire to invite your attention to what I believe should be a matter of great public interest and of especial interest to members of your profession, that is, the use of garbage by the city for filling-in purposes.

You are no doubt aware that this material, together with sewer excavations, is largely used for filling in at Rikers Island. I have been clearly of the opinion that this practice should be prohibited, and in order to strengthen my position before taking action, I referred the matter in a general way to the board of health of this city, and the board fully confirmed my views; but when I proposed to take action in the special case of the city, I was notified by the board that it had "approved the deposit of city refuse at Rikers Island, behind cribs properly constructed for that purpose, and approved its use for filling in at any place where it can be deposited below high-water mark."

At Rikers Island the deposit is made considerably above high-water mark.

I inclose the correspondence with the board of health, which I hope you will read, and when convenient return to this office.

This matter is of such importance from every point of view that I trust you will give me an expression of your opinion regarding it, as it would have great weight in solving the problem regarding the proper disposition of the city's refuse.

Very respectfully,

DANIEL DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

E. G. JANEWAY, M. D.,
New York City.

LETTER OF LIEUT. COMMANDER DANIEL DELEHANTY, U. S. NAVY.

OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
New York, March 24, 1894.

SIR: Referring to our conversation of yesterday concerning the use of garbage and the excavations from the city sewers for filling-in purposes at Rikers Island, I desire to quote, for your information, a paragraph in the application of the city of New York to the honorable Secretary of War, through Mr. Simon Stevens, dated September 22, 1892, requesting an extension of the harbor lines around Rikers Island:

"The accretion of land thus made around Rikers Island would be about 30 acres per annum for some ten or twelve years. Then, when the filling is completed, the island will be used exclusively for charitable purposes by the erection of new buildings or transferring those on Blackwells Island to their new home."

From this it is clear that it is the intention of the city to use this made land for residential purposes, and now that you are in possession of this fact, and also that the material which goes to make the land is largely composed of garbage and objectionable matter from the sewers, I hope you will have no objection to favoring me with an expression of your views regarding the matter, in order that I may submit all the facts in the case to the honorable Secretary of War.

It is demanded on the broad grounds of the public health and comfort, as well as for the protection of the waters of this harbor, that an inoffensive disposition be made of the garbage of this and adjacent cities. Any service you may render toward attaining this object will carry great weight and be most highly appreciated.

Very respectfully,

DANIEL DELEHANTY,
Lieut. Commander, U. S. Navy, Supervisor.

E. G. JANEWAY, M. D.,
New York City.

LETTER OF E. G. JANEWAY, M. D.

DEAR SIR: In answer to your communications I would say that I regard garbage and sewer accumulation as unfit material for filling-in purposes if the ground is to be used subsequently for residential purposes. The ideal disposition of the garbage would be by its collection separately from the ashes, and then its incineration at several places. I regret to say that on each occasion when those in charge of the street-cleaning department have attempted the separate collection of ashes and garbage that failure has resulted. To clean ashes no objection can be raised, nor would serious objection be raised against ashes mixed with such a small portion of garbage as could be removed and burnt. The emptyings from sewers ought, in my judgment, never to be placed in ground over which residences are to be erected.

I regret to say that the city of New York each summer establishes and creates a nuisance through the bureau of street cleaning, in that the refuse removed from the city by boats is emptied in the ocean, to be brought by currents to the shore of Long Island and of New Jersey. The New York Board of Health has definite and specific laws prohibiting any one of its citizens from doing to another citizen what the city of New York does to its neighbors. Moreover any citizen who should dump such refuse on a lot or street as is brought to the shores of Long Island and New Jersey would be arrested and punished. It seems to me time that the authorities should find an uninjurious method of disposal, and cease to create nuisances on the premises of her neighbors.

Yours, truly,

E. G. JANEWAY.

Lieut. Commander DANIEL DELEHANTY.

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